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Volume 77
1965

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The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 77, No. 1, MARCH 1965 · PAGES 1-108

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THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be ordered from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage paid at Lawrence, Kansas, U.S.A. Additional entry at Ann Arbor, Mich.

PRINTED IN U.S.A. The Allen Press, Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

Vol. 77, No. 1 | March 1965 | Pages 1–108

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SONG VARIATION IN MAINE SONG SPARROWS

Donald J. Borror

The Song Sparrow (*Melospiza melodia*) is a very common and widely distributed bird, and its songs are rapid, complex, and highly variable. Its life history and behavior are well known (Nice, 1937, 1943), and much has been written about its songs. Most past studies of the songs of this bird (Wheeler and Nichols, 1924; Nice, 1943; Saunders, 1951) have been based on auditory impressions; Brand (1935) analyzed the song recorded on sound film, and Mulligan (1963) presented a description of the songs of some California birds based on the audiospectrographic analysis of tape-recorded songs. The present paper is based on an analysis similar to that of Mulligan.

The purpose of this paper is to present an account of the variations in the songs of a local population, based on extensive recording over a period of several years. The variations found have raised a number of questions regarding song acquisition in the individual bird, the species-specific features of the songs, the ability of a Song Sparrow to recognize songs of the species or of particular individuals, and the role of song in the biology and evolution of the species; studies on these questions are currently under way and will be reported later.

METHODS

The study area.—The study area (Fig. 1) is located on Hog Island, in Muscongus Bay, Lincoln Co., Maine, and the adjacent mainland; it consists of about 40 acres, 30 on Hog Island and 10 on the mainland.

The Hog Island portion of this area consists of the Audubon Peninsula, located at the north end of the island; the buildings of the Audubon Camp of Maine are located at the north end of this peninsula. South of the buildings the peninsula was originally covered with a rather dense spruce forest, but a hurricane in September 1954, blew down nearly all the trees in a portion of the center of the peninsula, and quite a few trees in the southern part of the peninsula. The blown-down trees were cleared from the central blowdown area in 1955, but relatively little clearing has been done in the southern part of the peninsula. Since 1955 the central blowdown area (hereafter referred to as the Blowdown; see Fig. 1) has grown up in ferns, berry bushes, and small trees. Prior to the 1954 hurricane about 6 to 8 pairs of Song Sparrows nested on the peninsula each year; since the hurricane the nesting population has been 12 to 15 pairs each year.

The mainland portion of the study area (hereafter referred to as the Farm) is located across a channel of Muscongus Bay from the northern tip of the Audubon Peninsula. It is largely an open field bordered by a fairly dense second-growth woods; there are numerous trees and shrubs around the farm buildings. The field slopes from the farm buildings down to the bay, and about halfway down the hill, adjacent to the woods on the northeast side of the field, is a pond about 70 feet in diameter that was constructed in 1951. The field is kept in grass and weeds by mowing every few years, and has changed very little during the period of this study; six to ten pairs of Song Sparrows nest in this area each year.

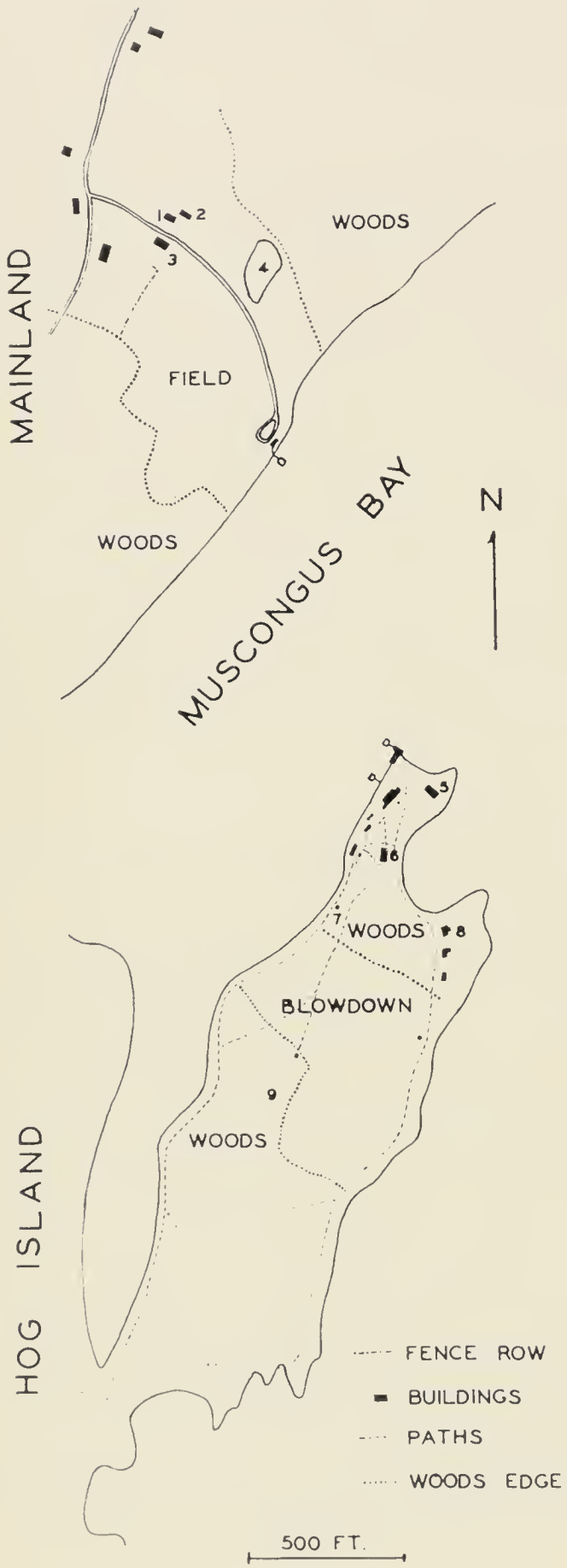

Fig. 1. Map of the Maine study area (the Audubon Camp of Maine), made from an aerial photograph taken in 1940; shorelines are at high tide. Numbers of buildings or areas 1, farmhouse; 2, north barn; 3, south barn; 4, pond; 5, Fish House; 6, Porthole; 7, Assistants' cabin; 8, First Aid Station; 9, bog. The Farm, on the mainland, includes the field and the woods bordering the field, from the numbered buildings to the Bay; the peninsula of Hog Island is the Audubon Peninsula.

TABLE 1
SUMMARY OF THE MAINE SONG SPARROW RECORDINGS STUDIED

	Study area			Bay Islands	Distance from study area on mainland			Total
	Hog Is.	Farm	Total		1–7 miles	8–15 miles	25–112 miles	
Birds	51	26	77	21	12	5	5	120
Recordings	481	105	586	29	19	5	5	644
Songs	4,997	1,648	6,645	279	208	61	19	7,212

Recording techniques.—The recordings from 1953 through 1961 were made with a Magnemite Model 610-E recorder, using a Brush BK-106 microphone mounted in a hand-held 24-inch parabolic reflector; the recordings in 1962 and 1963 were made with a Nagra III recorder, using a D-33 American microphone mounted in the reflector. All recordings were made at a tape speed of 15 ips.

The recordings made during the first few years of this study were made as opportunity offered; no attempt was made to stimulate the birds to sing. During the seasons from 1956 through 1961 occasional playbacks of Song Sparrow songs were made to birds on their nesting territories, and it was very soon discovered that such playbacks were highly effective in stimulating the birds to sing. The use of playbacks during these seasons was rather sporadic, due to difficulties with the playback equipment. In 1962 and 1963, when the Nagra recorder (which had a built-in speaker) was used, playbacks were frequently used to stimulate singing.

Playbacks of a Song Sparrow song to a Song Sparrow on its nesting territory usually produced a very characteristic reaction, although the strength of this reaction varied somewhat at different times and with different birds. In many cases, if the bird was not in evidence before the playback, the first or second song would bring it out, usually to a point near the speaker. The bird usually hopped and flew about a great deal, often coming quite close to the speaker, and it generally began to sing. In some cases it crouched low, holding its wings slightly above the horizontal and vibrating them, and it occasionally uttered a very soft song; this soft song was usually uttered for only a few seconds, after which the bird began singing one of its usual (louder) songs.

When a bird was found singing fairly consistently, a series of songs (usually a minute or two) was recorded; if the bird continued singing songs of the same pattern, the recording was stopped until the bird changed to another pattern; a series of this song was then recorded, and this process continued until the bird stopped singing. On many occasions during a recording (particularly in 1962 and 1963), if a bird stopped singing and flew to a distant point, a playback of its last-recorded song would result in the bird flying back to the vicinity of the recorder and beginning to sing again.

The number, song content, and source of the Maine Song Sparrow recordings on which this paper is based are shown in Table 1. All recordings were made by the writer, between early June and the middle of August.

Definition of terms.—The term *song*, in speaking of Song Sparrow vocalizations, refers to those vocalizations that are more or less prolonged, and normally consist of a varied series of notes and phrases. It includes Nos.

10 ("warbler"), 11 ("advertising song"), 12 ("flight song"), and 13 ("female song"), in Mrs. Nice's list (1943:274) of the 21 chief vocalizations of the Song Sparrow. The other vocalizations in this list, which are either single notes or short series of similar notes, might be collectively referred to as *call notes*. Since I have no recordings from the Maine birds that appear to represent what Mrs. Nice calls the warble and flight song, and since all the very soft songs recorded were of the same patterns as the louder advertising songs, my comments on song variation in the Maine birds refer only to variation in the advertising songs (Category No. 11 of Mrs. Nice's list).

A song is made up of notes and phrases; a *note* is a single sound, and a *phrase* is a group of one or more notes. The silent intervals between phrases are generally longer than those between the notes in a phrase. If a given note or phrase is uttered two or more times in succession at rates of 6 to 25 per second, the utterance is called a *trill*. The term *buzz* is used for sounds that appear buzzy to our ear, that is, sounds consisting of separate and similar notes uttered at rates greater than about 40 per second, or a note that fluctuates in pitch at a rate greater than about 40 per second.

A *song pattern* is a particular sequence of phrases *and the minor variations in this sequence*. Armstrong (1963) considers this term ambiguous, and uses the term "song-versions"; other writers use still other terms, such as "song types," "motifs," "sentences," or simply "different songs."

The song patterns of the Maine birds studied may be classified into two general types on the basis of the number and spacing of the introductory phrases: *Type 1*, with 1 to 5 (usually 2 to 4, rarely 6) introductory phrases that are relatively evenly spaced, or with the increase in rate gradual through the series (Figs. 2–5, 7, 9 A–C, and 10); and *Type 2*, with 5 to 20 introductory phrases, the first two or three of which are usually noticeably slower than the rest (Figs. 6, 8, and 9 D). The distinction between these two types of song patterns is not sharp, and the classification of a few patterns is somewhat arbitrary.

The identification of individual birds.—The songs in a given recording were all sung by the same bird, which was nearly always kept in view during the recording. Different recordings made in a given area during the nesting season, of a bird on its nesting territory, were assumed to be of the same bird: in most cases this assumption was supported by the same song patterns occurring in different recordings. Since none of the birds recorded was color-banded or otherwise marked for individual recognition, and since recognition was based solely on song pattern and territory, it is possible that errors have been made in the identification of some birds. Such errors are probably at a minimum, and it is believed that the vast majority of the birds were correctly identified.

Song analyses.—The recorded songs were analyzed with a Vibralyzer sound spectrograph, but it was not necessary to graph every song in a recording to be sure of its structure. A Song Sparrow generally sings a series of songs of one pattern before changing to another, and the recordings usually contained series of similar songs; after graphing the first song in a series, it was usually possible to determine the structure of the remaining songs in the series by listening to the recording played at a reduced tape speed. Songs that appeared a little different at this reduced speed were graphed to be sure of their structure.

In recording the structure of a song, the various notes and phrases were designated by letters; different letters were used for different types of notes or phrases. Both capital and lower case letters were used, sometimes with a superscript number, in order to have a different designation for each type of note or phrase. *I* (with a superscript number) was used for introductory phrases, and *T* (with a superscript number) was used for trill phrases. If a given phrase was uttered two or more times in succession, the number uttered was indicated by a subscript number. For example, the song shown in Fig. 2 A was recorded as $I^8\ I_2^{99}\ a\ D\ T_{10}^{63}\ i\ m\ x^0\ E^3\ N$.

Individual birds were designated by two capital letters, and their different song patterns by number; for example, pattern 4 of bird FH was designated as pattern FH-4. Each variation of a given pattern was designated by a letter, and sometimes one or two subscript numbers; the letter represented the particular sequence of phrases in the variation; one subscript number represented the number of trill phrases present (in a Type 1 song pattern) or the number of introductory phrases present (in a Type 2 pattern); two subscript numbers separated by a comma represented the number of introductory and trill phrases, respectively (in a Type 2 pattern that had a trill beyond the introductory phrases). Thus each song could be designated, more briefly than with a series of letters for the different phrases, as a particular variation of a particular pattern.

For example, the variation of pattern FH-4 (a Type 1 pattern) shown in Fig. 2 A was represented as FH-4L_{10} (the braeketed sequenee immediately above the graph): L represented the sequenee of phrases $I^8\ I^{99}\ a\ D\ T^{63}\ i\ m\ x^0\ E^3\ N$, and 10 the number of trill (T^{63}) phrases. The variation of pattern WT-8 (a Type 2 pattern) shown in Fig. 6 A was represented as WT-8C_6; C represented the phrase sequence $I^{21}\ B\ c\ E\ c\ Z^3$, and 6 the number of introductory (I^{21}) phrases. The variation of pattern IS-5 (a Type 2 pattern with a trill beyond the introductory phrases) shown in Fig. 6 C was designated as IS-5$C_{6,\ 10}$; C represented the phrase sequenee $I^4\ c^0\ E^2\ T^{22}\ c\ a\ E\ c\ Z^1$, 6 the number of introductory (I^4) phrases, and 10 the number of trill (T^{22}) phrases.

The graphs in this paper contain some examples of a given phrase (represented by a particular letter, or letter and superscript number) in different songs of the same bird (especially Figs. 2–5) and in the songs of different

TABLE 2

DATA ON THE INTRODUCTORY PHRASES IN MAINE SONG PATTERNS

Area		Maximum number of introductory phrases		Number or song patterns† with		
		Range	Average*	1 Type of 1	2 Types of 1	3 Types of 1
Study area	Hog Island	1–13	3.75 ± 0.12	244	41	6
	Farm	2–20	3.86 ± 0.21	130	28	2
Bay Islands		1–13	4.18 ± 0.42	41	8	0
Distance from study area on mainland	1–7 miles	2–9	3.50 ± 0.32	27	3	0
	8–15 miles	2–10	4.56 ± 1.07	9	0	0
	25–112 miles	2–4	2.80 ± 0.37	5	0	0
All Maine patterns		1–20	3.82 ± 0.10	456	80	8

* Averages are given plus or minus the standard error.
† The numbers of song patterns in this and other tables do not take into consideration cases of a given pattern being sung by two or more birds.

birds (especially Figs. 7–10), and illustrate some of the variation found in individual phrases. Because the phrases often varied slightly in different songs, it is perhaps a matter of opinion where the line is drawn between what is one type of phrase and what is another. The data in this paper regarding the number of types of phrases in different songs or in the vocabularies of different birds thus have a subjective basis, but are at least indicative of the existing variation.

The particular song (or songs) from which each graph in this paper was made is indicated by a hyphenated number; the number before the hyphen is the number of the recording, and the number after the hyphen is the number of the song in the recording.

CHARACTERISTICS OF THE SONGS OF THE MAINE BIRDS

The general character of the songs.—Most songs began with two or more similar phrases, the *introductory phrases*; the remaining phrases varied considerably in different songs. Each bird had a vocabulary of many different notes and phrases, and these were variously combined to produce different songs. The songs of a given bird that began with the same type (or types) of introductory phrases, followed by approximately the same sequence of other phrases, were said to represent a given song pattern. A bird usually sang songs of a given pattern for a time, then changed to another pattern; rarely, it would sing songs of two patterns more or less alternately.

TABLE 3

SUMMARY OF THE CHARACTERS OF THE INTRODUCTORY PHRASES IN MAINE SONGS

Character			Type 1 songs	Type 2 songs	All songs
First introd. phrase	Length (sec.)	Range	0.13–0.51	0.23–0.50	0.13–0.51
		Avg.*	0.341 ± 0.005	0.311 ± 0.010	0.336 ± 0.004
	Rate†	Range	1.96–7.69	2.00–4.35	1.96–7.69
		Avg.	2.936	3.220	2.977
Last introd. phrase	Length (sec.)	Range	0.13–0.64	0.08–0.20	0.08–0.64
		Avg.*	0.319 ± 0.003	0.121 ± 0.004	0.292 ± 0.004
	Rate	Range	1.56–7.69	5.00–12.50	1.56–12.50
		Avg.	3.137	8.236	3.419
Ratio, first I/last I		Range	0.38–2.13	1.77–3.59	0.38–3.59
		Avg.	1.069	2.558	1.148

* Averages of phrase length are given plus or minus the standard error.
† Rate is given as the number of phrases per second.

The songs included both musical and nonmusical notes. The musical notes varied in length from about 0.04 to 0.25 second (rarely longer), they were usually steady in pitch, and they contained a dominant frequency (usually the fundamental) and often harmonics. The nonmusical notes were usually short (up to 0.03 second in length) and very abruptly slurred, or buzzy. The buzzes were of three principal types; those designated as *Z* buzzes had a modulation frequency of 42 to 100 per second (average, 54.3 ± 0.9), and were usually 0.2 to 0.5 second in length; other buzzes had a modulation frequency of 145 to 165 per second (e.g., the first part of the *D* phrase, Fig. 2), and still others 300 to 335 per second (e.g., the last note in I^8, Fig. 2 B), and these were usually from 0.05 to 0.25 second in length. Most songs contained some buzzes, but their location in the song varied.

Most songs contained a trill following the introductory phrases; when a trill was present, its location in the song varied.

Pattern type.—The majority of the Maine song patterns, 473 (86.95%) of the 544, were of Type 1, that is, they began with 1 to 5 (usually 2 to 4) introductory phrases that were relatively evenly spaced (Table 5); 71 (13.05%) of the patterns were of Type 2, that is, they began with 5 to 20 introductory phrases, the first two or three of which were usually noticeably slower than the rest.

The introductory phrases.—Saunders (1951) and Nice (1943) state that most

introductory phrases in Song Sparrow songs are one-noted, with a few two-noted: the spectrograms of Mulligan (1963) show introductory phrases containing from one to three notes. The introductory phrases in the Maine songs studied contained from one to five (average, 2.5 ± 0.1) notes; about three-fourths of the introductory phrases contained two or three notes. In many of the introductory phrases containing two to four notes, one or two of these notes were very short and weak: such phrases would appear one- or two-noted to the ear.

Four of the 7,212 songs studied began with a very short note that normally occurred in the middle of the song:

FH-5M—1 of 44 FH-5 songs began with an *x* note
FH-7H_8—1 of 34 FH-7 songs began with an *i* note
PL-2B—1 of 11 PL-2 songs began with a c^0 note
PR-4C_{10}—1 of 50 PR-4 songs began with a *c* note

These notes (*x*, *i*, c^0, and *c*) are looked upon as accidental utterances in these songs, and are not treated as true introductory phrases.

The number of introductory phrases in a song varied from 1 to 20 (Table 2). It seldom varied in a given pattern more than a phrase or two in Type 1 patterns, or more than three or four phrases in Type 2 patterns; the figures in Table 2 are based on the maximum number found in each pattern.

The introductory phrases of most (83.82%) song patterns were all of the same type, but in a few patterns (14.71%) there were two types of introductory phrases (Figs. 2, 7 A, 9 A–C, and 10 A–C), and rarely (in 1.47% of the patterns) there were three types of introductory phrases (Table 2).

Table 3 contains data on the lengths of the first and last introductory phrases; the introductory phrases increased in rate through the series in most patterns. The ratio between the lengths of the first and last introductory phrases varied from 0.38 to 3.59, and for all patterns averaged 1.15: this ratio was greater (indicating a greater increase in phrase rate) in Type 2 than in Type 1 songs. The first introductory phrases were uttered at rates of 1.96 to 7.69 per second (average, 2.98 per second), and were faster in Type 2 (averaging 3.22 per second) than in Type 1 (averaging 2.94 per second) songs. The final introductory phrases were uttered at rates of 1.56 to 12.50 per second (average, 3.42 per second), and were much faster in Type 2 than in Type 1 songs (averaging 8.24 per second in Type 2, 3.14 per second in Type 1). Most (88.41%) of the Type 2 song patterns had the final introductory phrases uttered faster than six per second, or fast enough to be described as a trill.

TABLE 4

DATA ON THE TRILL PHRASES IN MAINE SONG PATTERNS

Area		Maximum no. of trill phrases		Trill phrase length (in seconds)		Trill phrases per second	
		Range	Average*	Range	Average*	Range	Average
Study area	Hog Is.	3–26	9.89 ± 0.12	0.046–0.192	0.078 ± 0.002	5.2–21.7	12.83
	Farm	4–16	9.09 ± 0.25	0.048–0.180	0.083 ± 0.002	5.6–20.8	11.99
Bay Islands		5–17	9.00 ± 0.47	0.043–0.150	0.078 ± 0.005	6.7–23.3	12.80
Distance from study area on mainland	1–7 miles	3–12	7.63 ± 0.52	0.057–0.172	0.091 ± 0.006	5.8–17.5	11.01
	8–15 miles	4–15	8.57 ± 1.36	0.060–0.143	0.095 ± 0.014	7.0–16.7	10.57
	25–112 miles	5–11	7.20 ± 1.07	0.068–0.117	0.095 ± 0.008	8.5–14.7	10.48
All Maine patterns		3–26	9.40 ± 0.14	0.043–0.192	0.081 ± 0.001	5.2–23.3	12.36

* Averages are given plus or minus the standard error.

The trills.[1]—Each bird usually had several different types of trill phrases in its vocabulary (see Table 7), and a given trill phrase often appeared in more than one of its song patterns. If a trill phrase appeared as a single phrase only, it was not called a trill; it was called a trill only if it appeared at least twice in succession in at least some variations of the pattern.

Only one instance (bird BD) was found of a bird using a particular phrase as an introductory phrase in one pattern (I^4 in BD-7; see Fig. 9) and as a trill phrase in another pattern (T^{35} in BD-9; I^4 is the same phrase as T^{35}; see Fig. 11 BB). No song pattern was found in which the trill phrases were similar to the introductory phrases in that pattern, although most (88.41%) of the Type 2 patterns had the final introductory phrases uttered fast enough to be described as a trill.

The occurrence of a trill in the Maine song patterns is shown in Table 5. Trills occurred much more commonly in Type 1 patterns than in Type 2 patterns: 387 (81.82%) of the Type 1 patterns contained a trill, while only 23 (32.39%) of the Type 2 patterns contained a trill. A trill beyond the introductory phrases was present in at least some songs of 410 patterns (75.37%) and absent in 134 patterns (24.63%); in 322 (78.54%) of the 410 patterns with a trill, the trill was present in all songs of the pattern, while in the remaining 88 (21.46%) only some of the variations contained the trill.

There were two trills beyond the introductory phrases in 15 (2.76%) of the song patterns; all but one of these were of Type 1. In 11 of these 15 patterns the two trills occurred in the same song; in the other 4 they occurred

[1] This discussion of trills applies only to phrases beyond the introductory phrases that were uttered at rates of 6 to 25 per second.

TABLE 5

SOME CHARACTERISTICS OF MAINE SONG PATTERNS

			Number of patterns from						
			Study area		Bay Islands	Distance from study area on mainland			Total
			Hog Is.	Farm		1–7 miles	8–15 miles	25–112 miles	
Song pattern type		Type 1	255	141	38	27	7	5	473
		Type 2	36	19	11	3	2	0	71
		Total	291	160	49	30	9	5	544
Occurrence of a trill beyond introductory phrases	Trill present	In all songs	167	104	23	19	4	5	322
		In some songs	54	21	6	4	3	0	88
		Total	221	125	29	23	7	5	410
	Trill absent		70	35	20	7	2	0	134
Location of trill*	Immediately following I		51	20	2	2	0	1	76
	1–3 phrases after I		93	49	9	10	2	4	167
	Later in song		84	58	19	11	6	0	178
Occurrence of *Z* buzzes	*Z* present	In all songs	135	88	35	15	4	2	279
		In some songs	96	29	6	6	3	1	141
		Total	228	115	40	19	7	3	412
	Z absent		63	45	9	11	2	2	132
With two *Z* buzzes			13	6	3	4	0	0	26

* In 11 patterns (7 from Hog Is., 2 from the Farm, 1 from the Bay Islands, and 1 8–15 miles from the study area on the mainland) the location of the trill varied in different variations of the pattern.

in different variations of the pattern. In two other patterns, some songs contained a trill consisting of two slightly different types of trill phrases (Fig. 4 C).

Table 4 contains data on the number, length, and rate of the trill phrases in the Maine song patterns. The number of trill phrases in patterns containing a trill varied from 0 (variations lacking the trill) to 26. The phrase rate in the trills varied from 5.2 (the slowest rate of a phrase type which, in different patterns, averaged more than 6 per second) to 23.3 phrases per second. The trill was usually between 0.5 and 1.0 second in length, and the number of phrases in it was generally inversely proportional to their length.

The location of a trill beyond the introductory phrases varied in different patterns, and in 11 (2.68%) of the 410 patterns containing a trill the location varied in different variations of the pattern. The trill was immediately after

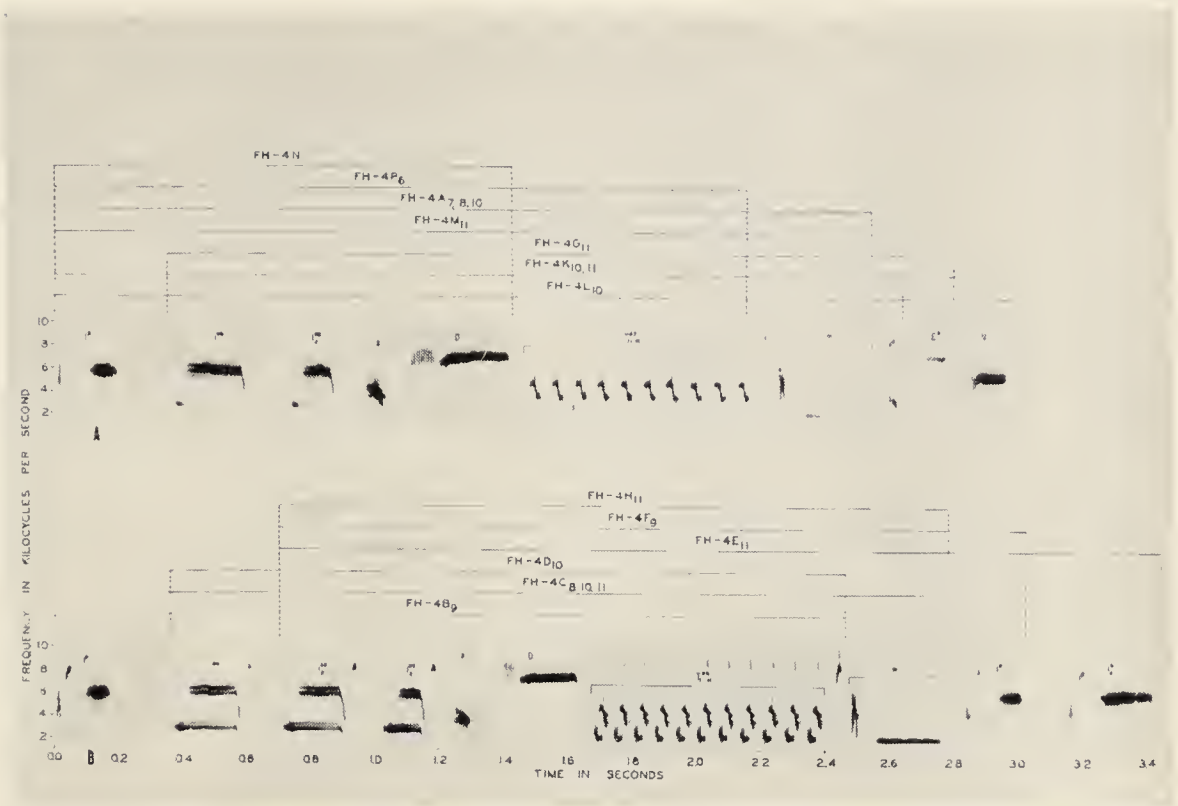

FIG. 2. Variations in the songs of pattern FH-4 (A from 2161-3, B from 1538B-3 and 1506B-24).

the introductory phrases in 76 (18.54%) of the 410 patterns, from one to three phrases after the trill in 167 (40.73%), and later in the song in 178 (43.41%) patterns (Table 5).

The Z buzzes.—Most song patterns contained what have been termed Z buzzes, which had modulation frequencies of 42 to 100 per second. Table 5 shows the incidence of these buzzes; they occurred in 412 (75.74%) of the 544 patterns.

Song length.—Some information on song length is indicated in the figures. There was a great deal of variation in the length of the Maine songs, most of it due to variation within patterns. A Song Sparrow starting a song may stop anywhere along a given sequence of phrases, even after the first introductory phrase. Most songs were at least 2 seconds in length, and the majority were between 2.5 and 3.0 seconds in length; some were as long as 3.5 seconds, and a few were as long as 4.0 seconds.

Singing rate.—Singing rate was calculated from measurements of the time from the beginning of one song to the beginning of the next; this interval is called the cadence by Reynard (1963). Measurements of 206 such intervals in normal song, from 16 birds, selected at random, varied from 6.0 to 22.5 seconds, and averaged 11.44 ± 0.20 seconds (corresponding to a rate of

TABLE 6

INCIDENCE OF THE MOST COMMON PHRASES IN THE SONGS OF THE MAINE BIRDS

Phrase	Figures	Number of song patterns from					
		Study area			Distance from study area		
		Hog. Is.	Farm	Total	8 miles or less	8–15 miles	25–112 miles
I^{1}	6, 9, 10	9	13	22	2	0	0
I^{10}	9, 10	10	13	23	4	0	0
I^{26}	6, 9	12	14	26	7	2	0
I^{29}	4, 5	20	11	31	3	1	0
I^{36}		15	9	24	2	0	0
I^{72}	4	7	13	20	0	1	0
I^{98}	6	13	10	23	3	0	0
I^{99}	2, 8	16	8	24	1	0	0
T^{1}	5, 7	33	14	47	7	2	0
T^{3}	7	21	11	32	1	0	0
T^{5}	4, 10	27	21	48	9	1	0
T^{6}	9	16	10	26	1	0	0
T^{11}	10, 11	10	11	21	1	1	0
a	2–6, 9	38	23	61	20	2	2
A	12	33	23	56	14	0	0
b	3–5, 7, 10	38	26	64	17	1	0
B	3–7, 9, 10	36	22	59	7	1	0
*c**	2–10	51	26	77	33	5	4
c^{0}	6	29	16	45	10	3	1
E^{2}	5–7	29	18	47	15	2	1
f	3, 4, 6, 8–10	36	24	60	16	2	0
m	2–4, 7	31	17	48	22	1	0
M	6, 9	20	13	33	6	0	0
Z^{1}	3, 4, 6, 9, 10	43	21	64	16	2	0
Z^{3}	6, 8	29	9	38	10	0	0

* *c* is the first note of an *m* phrase.

5.2 ± 0.1 songs per minute). This figure corresponds fairly well with the average cadence given by Reynard (1963) of 11.8 seconds.

If a bird was stimulated by playbacks of Song Sparrow songs, its singing rate was significantly higher. Measurements of 215 intervals in such stimulated song. from seven birds, selected at random, varied from 4.5 to 14.0 seconds. and averaged 7.33 ± 0.09 seconds (corresponding to a rate of 8.2 ± 0.1 songs per minute).

Local variation.—The bulk of the Maine recordings were made in the study area (see Fig. 1 and Table 1), but some were made on various islands in Muscongus Bay (½ to 8 miles from the study area), and on the mainland 1½ to 112 miles from the study area. The distribution of the 544 patterns is shown in Table 5.

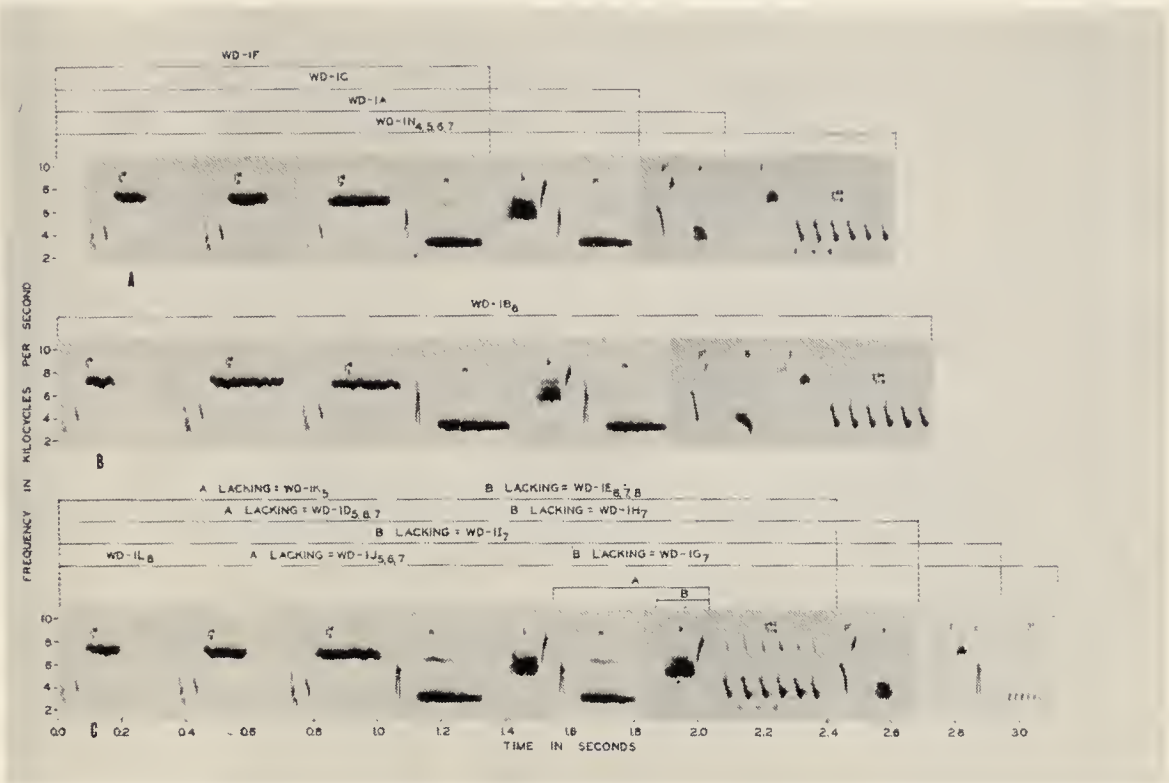

FIG. 3. Variations in the songs of pattern WD-1. The song shown in A (5274-1) was recorded in 1961, that in B (2936-3) was recorded in 1957, and that in C (4232-6) was recorded in 1959. One song in recording 2936 contained an *a* note (as in A and C) rather than a *B* note.

The patterns from different Maine areas differed in various characteristics—in the proportions of the two types of song patterns (Table 5), the number of introductory and trill phrases (Tables 2 and 4), the number of types of introductory phrases in a given pattern (Table 2), in the presence of a trill in the song (Table 5), in the length and rate of the trill (Table 4), in the location of the trill (Table 5), and in the incidence of *Z* buzzes (Table 5), but these differences were for the most part not significant. The phrase rate in the trills was significantly higher in patterns from Hog Island than in those from the Farm area; the maximum number of trill phrases was greater in patterns on the study area than elsewhere in Maine; the trill when present occurred later in the song in relatively more song patterns of birds on the Bay Islands than elsewhere, and in relatively fewer patterns on the study area than elsewhere; and the first introductory phrases of the song were uttered significantly faster in patterns on the mainland portion of the study area than in patterns on Hog Island. Relatively more of the patterns of birds on the Bay Islands (other than Hog Island) lacked a trill, and more of the island patterns were of Type 2, than was the case with patterns of birds elsewhere in Maine.

Table 6 shows the incidence of the most common types of phrases in the song patterns of the Maine birds, both within and outside the study area. For each of these phrases the incidence was less outside the study area than in it, and in general the farther away from the study area one goes, the less common the phrase is.

The two portions of the Maine study area are separated by a channel of Muscongus Bay about 300 yards wide (Fig. 1); a Song Sparrow song can be heard across this channel. The data in Table 6 show that for each phrase listed there is a somewhat different incidence in the two portions of the study area, but these differences are in most cases (all except I^{1}, I^{10}, and I^{72}, which occur in the vocabularies of significantly more Farm birds than Hog Island birds) not significant. The island and mainland populations of the study area thus appear to be essentially a single population, as far as the character of the phrases in their songs is concerned.

The data in Table 6 indicate that we have in the Song Sparrow what might be called local dialects, and it suggests that the various notes and phrases of the song are learned by listening to other birds, and that the majority of the birds in the study area were there at the time of their life when the phrases of the song are acquired. Mr. Joseph M. Cadbury, who has banded a number of Song Sparrows on the study area, informs me (in correspondence) that he has a number of records of birds banded as nestlings on the area that have returned as adults.

The songs of a few birds in the study area were such as to suggest that they learned the phrases of their songs somewhere outside the study area. The songs of IN, for example, a bird that nested near the First Aid Station on Hog Island in 1955, 1956, and 1957, contained some unique phrases: five of its six introductory phrase types and three of its four trill phrase types occurred in the songs of no other birds studied. The songs of PA, which nested in the Blowdown in 1960, 1961, and 1962, also contained some unique phrases: four of its eight introductory phrase types and four of its five trill phrase types occurred in the songs of no other birds studied. IN and PA probably hatched and grew up somewhere outside the study area.

SONG VARIATION IN INDIVIDUAL BIRDS

Vocabularies of individual birds.—The number of different phrases found in the songs of 53 birds recorded in the study area is shown in Table 7; each of these birds was represented in the recordings by either 50 or more songs or by at least six song patterns. The vocabularies of these birds varied from 23 to 53 phrases, and averaged 37.6; since 50 songs may be inadequate to determine a bird's vocabulary, some of these figures may be only a minimum estimate. The vocabularies of the 20 birds represented by 100 or more songs

ranged from 26 to 51 phrases, and averaged 40.9; those of the 10 birds represented by 200 or more songs ranged from 26 to 51 phrases, and averaged 41.2. It thus appears that the birds studied had, on the average, about 40 phrases in their vocabularies.

Variation within a song pattern.—Practically every song pattern in the recordings, if represented by two or more songs, showed some variation. For example, there were 18 variations in the 39 songs studied of pattern FH-4 (Fig. 2):

1. $I^{8}\ I_{2}^{99}\ a\ D\ T_{10}^{63}\ i\ m\ x^{0}\ E^{3}\ N$ ..... FH-4L$_{10}$
2. $I^{8}\ I_{2}^{99}\ a\ D\ T_{10}^{63}\ i\ m\ x^{0}\ E^{3}$ ..... FH-4K$_{10}$
3. $I^{8}\ I_{2}^{99}\ a\ D\ T_{11}^{63}\ i\ m\ x^{0}\ E^{3}$ ..... FH-4K$_{11}$
4. $I^{8}\ I_{2}^{99}\ a\ D\ T_{11}^{63}\ i\ m\ x^{0}$ ..... FH-4M$_{11}$
5. $I^{8}\ I_{2}^{99}\ a\ D\ T_{7}^{63}\ i\ m$ ..... FH-4A$_{7}$
6. $I^{8}\ I_{2}^{99}\ a\ D\ T_{8}^{63}\ i\ m$ ..... FH-4A$_{8}$
7. $I^{8}\ I_{2}^{99}\ a\ D\ T_{10}^{63}\ i\ m$ ..... FH-4A$_{10}$
8. $I^{8}\ I_{2}^{99}\ a\ D\ T_{6}^{63}$ ..... FH-4P$_{6}$
9. $I^{8}\ I_{2}^{99}\ a\ D$ FH-4N
10. $I^{8}\ I_{3}^{99}\ a\ D\ T_{9}^{63}\ c^{1}$ ..... FH-4B$_{0}$
11. $I_{3}^{99}\ a\ D\ T_{8}^{63}\ i\ m$ ..... FH-4C$_{8}$
12. $I_{3}^{99}\ a\ D\ T_{10}^{63}\ i\ m$ ..... FH-4C$_{10}$
13. $I_{3}^{99}\ a\ D\ T_{11}^{63}\ i\ m$ ..... FH-4C$_{11}$
14. $I_{3}^{99}\ a\ D\ T_{10}^{63}\ c^{1}$ ..... FH-4D$_{10}$
15. $I_{2}^{99}\ a\ D\ T_{11}^{63}\ i\ m\ I_{2}^{8}$ ..... FH-4E$_{11}$
16. $I_{2}^{99}\ a\ D\ T_{9}^{63}\ i\ m\ I^{8}$ ..... FH-4F$_{9}$
17. $I_{2}^{99}\ a\ D\ T_{11}^{63}\ i\ m$ ..... FH-4H$_{11}$
18. $I_{2}^{90}\ a\ D\ T_{11}^{63}\ i\ m\ x^{0}\ E^{3}$ ..... FH-4G$_{11}$

The songs of FH-4 showed several sorts of variations: (a) in the number of introductory phrases (two or three), (b) in the type of introductory phrases (the first ten of the above variations contained two types of introductory phrases, and the rest only one type—at least at the beginning of the song), (c) in the number of trill (T^{63}) phrases (6 to 11), (d) in where along the sequence the song ended (cf. variations 3, 4, and 5), and (e) in the way the song ended (cf. 10 and 11). This pattern was one of the few found in which phrases used by the bird as introductory phrases (I^{8}) also appeared later in the song (variations 15 and 16).

FH had two patterns beginning with I^{29} phrases, FH-2 and FH-13; these patterns were considered different, even though they began with the same introductory phrases, because the remaining phrases were different (see Fig. 4, C and D). Pattern FH-13 was unusual in that its trill usually contained two types of phrases (T^{38} and T^{48}); the subscript numerals in the pattern designation FH-13A$_{3-5}$ refer to the numbers of T^{38} and T^{48} phrases, respectively.

The song patterns of FH were sufficiently different that their delimitation presented no problem; in many birds the delimitation of patterns was not as simple. For example, two groups of variations of the songs of BG were very

Table 7

Vocabularies and Repertoires of a Selected Group of Maine Birds

Bird	Location[1]	Years recorded	No. of recordings	No. of songs	No. of song patterns	No. of song variations	Songs per variation	No. of different phrases in vocabulary				
								I	T	Z	Other	Total
AP	M	61	7	115	8	61	1.885	9	5	3	23	40[2]
BA	HI	57, 58, 59	28	202	9	178	1.135	10	6	2	25	43
BB	M	61	7	52	5	28	1.857	6	5	2	11	24
BD	HI	56, 58, 59, 60, 61, 62	41	404	10	151	2.675	11	6	3	26	46[3]
BG	HI	59, 60	9	44	6	23	1.913	6	3	2	13	24
BH	M	62	2	33	6	17	1.941	5	2	3	24	34
BN	M	61	3	52	6	37	1.405	8	3	3	15	29
BT	HI	59, 60, 61	13	80	9	51	1.569	9	5	2	26	42
CB	HI	59, 60, 61, 62	30	269	13	83	3.241	13	6	4	25	48
CF	1–8	60, 61	5	124	9	48	2.583	10	5	3	24	42
CL	HI	58, 59, 60	11	94	12	74	1.270	12	7	3	31	53
CW	HI	56, 57	6	28	6	22	1.273	5	5	4	24	38
DC	HI	58, 59, 60, 61	9	86	7	53	1.623	9	5	3	19	36
DH	HI	62, 63	8	109	8	72	1.514	8	3	2	22	35
EA	BI	61	2	72	6	28	2.571	10	3	5	17	35
EM	BI	58	4	24	7	14	1.714	6	6	2	20	34
FG	HI	57	13	161	6	67	2.403	6	3	1	22	32
FA	HI	62, 63	2	116	11	71	1.634	13	5	3	26	47
FB	HI	63	2	62	8	35	1.771	8	5	4	26	43
FH	HI	55, 56	61	462	13	190	2.432	13	7	4	27	51[4]
FP	HI	62	6	135	9	65	2.077	10	7	2	22	41
HI	BI	58	1	30	6	16	1.875	5	3	3	19	30[5]
IN	HI	55, 56, 57	10	201	6	62	3.242	6	4	3	17	30
IS	HI	58, 60, 61, 62	15	251	8	109	2.303	10	5	3	15	33
IV	HI	62	3	93	7	53	1.755	9	5	2	25	41
MA	M	63	4	62	8	38	1.632	5	6	2	16	29
MC	M	63	7	90	6	46	1.957	9	5	4	23	41[2]
MH	M	59, 60	4	85	9	45	1.889	6	5	2	21	34
MI	M	63	5	104	8	37	2.811	7	5	3	24	39
MP	M	63	6	77	6	47	1.638	7	4	3	20	34
MT	M	62, 63	3	98	8	53	1.849	6	5	2	25	38
NB	HI	57	8	66	10	43	1.535	10	6	4	20	40
NC	M	61, 62	6	65	5	31	2.097	6	2	1	14	23

[1] BI, Bay Islands; HI, Hog Island; M, Nash Farm; 1–8, mainland, within 8 miles of the study area.

[2] One phrase, counted here as an I phrase, appeared as an introductory phrase in one pattern, and later in the song in another pattern.

[3] One phrase, counted here as an I phrase, was used as an introductory phrase in one pattern, and as a trill phrase in another pattern.

[4] Three different phrases, counted here as I phrases, were used both as introductory phrases and later in the song; one of these appeared as an introductory phrase and a final phrase in the same song (I^8, Fig. 2); the other two appeared as an introductory phrase in one pattern and later in the song in another pattern.

[5] One phrase, counted here as a T phrase, appeared as a trill phrase in one pattern, and as a single phrase only in another pattern.

TABLE 7. (*Continued*)

Bird	Location[1]	Years recorded	No. of recordings	No. of songs	No. of song patterns	No. of song variations	Songs per variation	No. of different phrases in vocabulary				
								I	T	Z	Other	Total
ND	M	57	3	54	9	29	1.862	8	4	2	21	35
NF	M	59, 60, 61	11	97	12	39	2.487	11	9	4	28	52
NG	M	63	5	88	8	44	2.000	9	5	3	22	39[6]
NH	M	61, 62	8	101	8	51	1.980	7	5	4	24	40
NJ	M	63	4	48	6	30	1.600	9	4	4	22	39
NM	M	62	2	34	6	23	1.478	7	4	3	17	31
NR	M	62, 63	5	185	8	102	1.814	9	6	4	28	47
NU	M	63	1	49	6	34	1.441	6	5	2	19	32
NX	M	61, 63	2	89	10	44	2.023	12	6	2	21	41[2]
PA	HI	60, 61, 62	9	84	7	35	2.400	8	5	6	22	41
PH	HI	55, 56, 57	45	285	14	156	1.827	12	7	4	25	48
PL	HI	58	6	60	6	45	1.333	7	2	3	19	31
PO	HI	60	8	86	8	45	1.911	6	5	3	19	33
PR	HI	59, 60, 62, 63	30	417	10	158	2.639	11	6	2	24	43[5]
SC	HI	61, 62	8	128	11	82	1.561	10	8	4	21	43
SP	HI	57	2	52	8	27	1.926	8	6	3	19	36
SS	HI	62	2	82	8	44	1.864	9	6	3	21	39
WD	HI	57, 58, 59, 61	53	384	6	144	2.667	6	4	2	14	26
WH	HI	59	13	63	4	33	1.909	4	4	2	14	24
WT	HI	60, 61, 62	16	226	10	92	2.457	7	6	5	26	44

[6] One phrase, counted here as an I phrase, appeared later in the song in the same pattern in which it was used as an introductory phrase, and later in the song only in another pattern.

similar, differing principally in the character of the introductory phrases (Fig. 4, A and B); these were considered different patterns because they began with different introductory phrases. These songs sound almost the same in the field; only a very careful observer would notice the difference in the introductory phrases.

Space here does not permit a complete listing of all the 3,616 variations found in the 544 song patterns of the Maine birds, but the following types of variation within a pattern were found:

1. Variation in the number of introductory phrases (Fig. 2).

2. Variation in the type of introductory phrases (e.g., pattern FH-4, Fig. 2). In patterns beginning with two or three types of introductory phrases, some songs of the pattern lacked one of the phrase types, or (in rare instances) there was a variation in the sequence of the different introductory phrase types.

3. Variation in the occurrence of a trill beyond the introductory phrases. In 88 of the 544 patterns, some variations of the pattern contained a trill and others lacked it (Table 5).

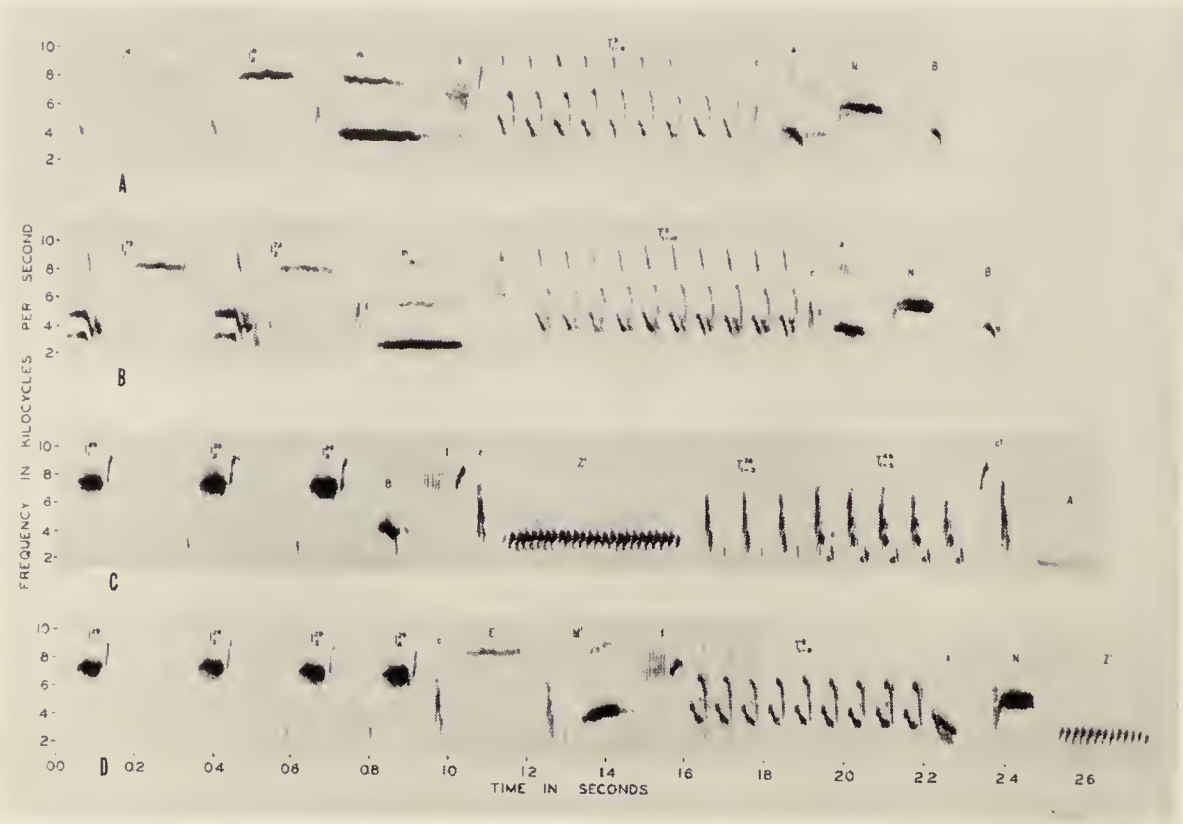

FIG. 4. Graphs illustrating the delimitation of song patterns. A, pattern BG-3A_9 (4260-5); B, pattern BG-5C_{10} (4362-17); C, pattern FH-13A_{3-5} (2054-13); D, pattern FH-2D_9 (2054-14). A and B differ only in the character of the introductory phrases and in the pitch of the low note in phrase *m*; they are designated as different patterns because of the differences in the introductory phrases. C and D are considered as different patterns, even though the introductory phrases are the same, because the remainder of the song is quite different in the two cases.

4. Variation in the number of trill phrases (Figs. 2 and 3).

5. Variation in the location of the trill in the song (when it was present); this type of variation occurred in 11 of the 544 patterns.

6. Variation in where, along a given sequence of phrases, the song ended. (An utterance was considered a song if it contained the first *two* phrases; a single introductory phrase, which a bird would occasionally utter, was not counted as a song.) This sort of variation was found in nearly every pattern.

7. Variation in the presence or absence of certain phrases (other than *T*) (Figs. 3 and 5).

8. Variation in the sequence of a few phrases (e.g., in pattern BA-1; see Fig. 5, C and D).

9. Variation in the number of phrases other than the introductory and trill phrases (Fig. 5, A and B).

10. Variation in the character of particular phrases. Such variation occurred chiefly in cases where the bird appeared to hesitate or falter at a par-

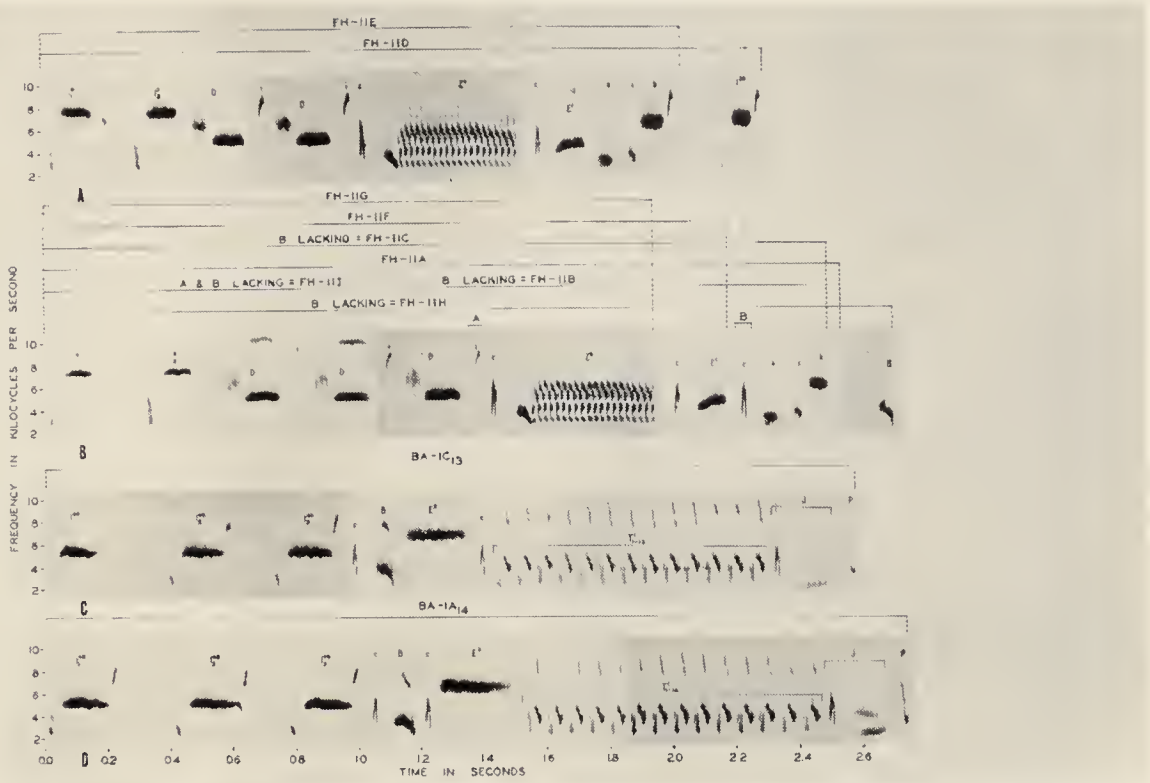

FIG. 5. A and B, variations in the songs of pattern FH-11; C and D, two variations of pattern BA-1 that differ in the sequence of two notes (*c* and E^2). A, 1506B-15; B, 1486B-2 and 2179-1; C, 3504-1; D, 2826-2.

ticular phrase in occasional songs, and thus render the phrase a little different than usual; occasionally a phrase would be a little different in songs recorded at different times, or in different seasons (cf. Fig. 11, S and T, recorded the same season).

11. Variation in the ending of the song (Fig. 2).
12. Slight variations in note or phrase length.
13. Variations in the relative loudness of particular notes or phrases.

Repertoires.—Saunders (1951:107) gives the following data on the song repertoires of 13 birds:

1 bird	had 6	"different	songs"
1 bird	had 8	"	"
2 birds	had 9	"	"
1 bird	had 11	"	"
2 birds	had 12	"	"
1 bird	had 15	"	"
2 birds	had 16	"	"
2 birds	had 18	"	"
1 bird	had 24	"	"

Wheeler and Nichols (1924) give 19 as the maximum number of songs from one bird, and Mrs. Nice (1943) mentions ten birds with 7 to 10 songs, four with 9 songs, eight with 10 to 12 songs, one with 13 songs, and one with 17 songs. Mulligan (1963) found 10 to 23 (average, 15.8) "song types" in 13 "rather well-studied" birds.

Table 7 gives data on the vocal repertoires of 53 birds for which the most data (6,558 songs, 426 patterns, 3,205 variations) were available. Since 50 songs (fewer in some of these 53 birds) are inadequate to determine a bird's repertoire, the figures presented represent only a minimum estimate of each bird's repertoire. The repertoires of these birds varied from 5 to 14 song patterns (average, 8.04) and from 14 to 190 total variations (*different* songs) (average, 60.5) per bird. One bird had 14 patterns, two had 13, two had 12, and two had 11. If the averages are calculated from the 20 birds represented in the recordings by 100 or more songs, they are 9.25 patterns and 99.0 different songs per bird; if they are calculated from the 10 birds represented by 200 or more songs, they are 9.9 patterns and 132.3 different songs per bird.

The number of songs per variation in these 53 birds varied from 1.270 to 3.242. The number of songs per variation in the ten birds represented by 200 or more songs are of interest:

FH	(462 songs)	2.432
PR	(417 songs)	2.639
BD	(404 songs)	2.675
WD	(384 songs)	2.667
PH	(285 songs)	1.827
CB	(269 songs)	3.241
IS	(251 songs)	2.303
WT	(226 songs)	2.457
BA	(202 songs)	1.472
IN	(201 songs)	3.242

These figures indicate that the songs of some birds were more variable than those of other birds (e.g., the songs of PH and BA were more variable than those of CB and IN), but they do not indicate an upper limit of the variability.

Table 8 shows the variability in the 47 patterns that showed 20 or more variations, or were represented by 40 or more songs; the variability in these patterns ranged from 7.000 to 1.212 songs per variation. Most of the patterns with the least variability (e.g., BD-3, PR-8, and IN-1) were patterns without a trill. Patterns that lacked a trill and still showed considerable variability (e.g., DC-1 and FG-2) were of Type 2, in which the number of introductory phrases was subject to greater variation than in songs of Type 1. Variations in the number of trill phrases account for a large part of the variation within a pattern.

The two patterns represented by the most songs (WD-2 and WD-3) were

Table 8

Song Variability in Patterns Represented by 40 or More Songs or by 20 or More Variations

Song pattern	Pattern type	Trill*	No. of songs	No. of variations	Songs per variation
BA-1	1	±	40	33	1.212
BA-2	1	±	29	22	1.318
BA-4	1	+	47	32	1.469
BA-6	2	±	64	34	1.883
BD-1	1	±	66	38	1.737
BD-2	1	+	43	24	1.792
BD-3	1	0	77	11	7.000
BD-4	1	+	48	27	1.778
BD-7	1	±	80	21	3.810
CB-1	1	+	91	21	4.333
CB-4	1	±	49	14	3.500
DC-1	2	0	36	22	1.636
DC-3	1	±	31	21	1.476
DH-5	1	+	37	26	1.423
FA-5†	1	+	27	22	1.227
FG-2	2	0	30	22	1.364
FG-4	1	+	41	19	2.158
FH-1	1	+	45	7	6.429
FH-5	1	±	44	21	2.095
FH-6	1	±	41	20	2.050
FH-7	1	+	34	24	1.417
FH-10	1	±	49	15	3.267
FH-13**	1	±	27	20	1.350
FP-2	1	±	43	21	2.048
IN-1	2	0	52	9	5.778
IN-2	1	±	41	15	2.733
IN-3	1	+	51	12	4.250
IS-1	1	+	48	29	1.655
IS-5	2	+	39	23	1.696
NR-3	1	+	52	18	2.889
NR-8	1	+	36	28	1.286
PH-1	1	+	35	26	1.346
PH-2	1	±	48	28	1.714
PH-5	1	±	44	14	3.143
PR-1	1	±	59	17	3.471
PR-2	1	±	68	31	2.194
PR-3	1	±	58	15	3.867
PR-4	1	+	50	28	1.786
PR-5	1	±	54	19	2.842
PR-8	2	0	54	10	5.400

* +, a trill present in all songs of the pattern; ±, a trill present in some songs of the pattern; 0, trill lacking.

† This pattern contained two trills.

** When a trill was present, it contained phrases of two types.

TABLE 8 (*Continued*)

Song pattern	Pattern type	Trill*	No. of songs	No. of variations	Songs per variation
WD-1	1	±	64	22	2.909
WD-2	1	±	118	41	2.634
WD-3	1	+	94	38	2.474
WD-5	1	+	43	14	3.071
WD-6	1	±	51	20	2.550
WT-1	1	+	35	20	1.750
WT-4	1	±	42	14	3.000
Average			50.11	21.87	2.291

also the patterns represented by the most variations (Table 8). Apparently, the more songs of a pattern (or a bird) one examines, the more variations he will find. There is probably an upper limit to the number of variations in the songs of a given pattern (or bird), but it is difficult from the data here presented to determine what this limit is. Some patterns were subject to a greater amount of variation than others, depending (at least in part) on whether or not they contained a trill.

Since each Maine bird had, on the average, between 9 and 10 song patterns, and each pattern had an average of a little over 20 variations, it seems likely that we could expect each bird to have a repertoire of about 200 *different* songs: the nearest to this of any bird recorded was FH (represented by 462 songs), with 190 different songs. One would probably have to examine 500 or more songs of a bird to find 200 or more variations.

To compare the repertoires of the Maine birds studied with those of birds mentioned by Wheeler and Nichols (1924), Nice (1943), Saunders (1951), and Mulligan (1963), it is necessary to speak of song *patterns* rather than of *different* songs. The number of patterns in the Maine birds is lower than that mentioned by these writers; this may indicate less versatility in the birds studied, or it may be that some of the variations I have included in a single pattern would be recognized as "different songs" or different "song types" by these writers.

Song pattern preferences.—It has been stated (Nice, 1943:121–122) that a Song Sparrow usually goes through its whole repertoire before repeating any one song pattern, but it has been noted (Saunders, 1924; Nice, 1943) that a bird will often sing some of its songs more than others. Table 9 contains data on the song pattern preferences—as shown by the incidence of different patterns in the recordings studied—of the 12 Maine birds that had ten or more song patterns. Instances where a particular pattern appears only a very few times compared with the incidence of other patterns might represent songs by

TABLE 9

DATA ON THE SONG PATTERN PREFERENCES OF SOME MAINE BIRDS

Song pattern number	Bird											
	PH	CB	FH	CL	NF	FA	SC	BD	NB	NX‡	PR	WT
1	35	91	45	14	28	6	31	65	4	2	59	35
2	48	20	24	24	17	11	3†	43	3	4	68	19
3	23	37	34	2†	21	19	12	77	3	16	58	29
4	19	49	39	7	2†	3†	13	48	3	16	50	42
5	44	28	44	3†	2†	27	25	51	15	9	54	29
6	27	23	41	2†	13	17	14	1*	6	14	25	22
7	14	7*	34	13	6*	7	7	80	7	9	26	13
8	21	3*	28	3†	1†	8	4*	4	3	10	54	13
9	7†	4*	30	6	3†	2†	5	8	3	5	19	20
10	34	2†	49	3†	1†	1†	5	27	19	4	4†	4†
11	1†	1†	29	9	2†	15	9					
12	4†	2†	38	8	1†							
13	6†	2†	27									
14	2†											
Total songs	285	269	462	94	97	116	128	404	66	89	417	226
Total variations	156	83	190	74	39	71	82	151	43	44	158	92

‡ One of the recordings studied contained all these patterns.

* In one or more recordings containing this pattern only; this pattern *could* have been sung by a different bird.

† A pattern unquestionably by this bird; it was in one or more recordings with one or more other patterns.

a different bird, but this possibility has been ruled out in most of the cases shown in Table 9. It is apparent that a bird will sing some of its song patterns much more frequently than others, and some patterns (e.g., PH-11, which appeared only once in 285 songs, and PR-10, which appeared only four times in 417 songs) are sung only very rarely.

Thirty of the Maine birds were recorded in two or more seasons: 16 in two seasons, 8 in three seasons, 5 in four seasons, and 1 in six seasons: 26 of these birds are included in Table 7. Table 10 contains data on the song patterns sung by nine of these birds each year they were recorded. In only one of these cases (FH) was each of the bird's song patterns recorded each year; in the other cases there were one or more years in which certain patterns were not recorded. The presence of a given pattern in different years indicates that it is fixed: once a song pattern is developed by a Song Sparrow, it remains in the bird's repertoire the rest of its life. The absence of some patterns from the recordings of a bird in certain years is probably the result of a change in the song preferences of the bird, and/or not enough songs were recorded to secure the bird's complete repertoire. In at least some cases (e.g., patterns 5, 9, 11.

Table 10

Data on the Variations in Song Pattern Preference in Different Years in Some Maine Birds

Year	Number of songs of song pattern														Total songs
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Bird BA															
1957	8	11	4	15	4	14	8	–	–						64
1958	11	5	–	11	5	–	3	10	9						54
1959	21	13	13	21	10	50	–	–	17						145
Total	40	29	17	47	19	64	11	10	26						263
Bird BD															
1956	9	–	–	–	–	–	–	–	–	–					9
1958	19	19	11	21	24	1	3	–	–	–					98
1959	7	2	–	–	–	–	28	4	–	–					41
1960	17	6	34	16	10	–	24	–	1	8					116
1961	11	16	23	5	15	–	13	–	2	6					91
1962	2	–	9	6	2	–	12	–	5	13					49
Total	65	43	77	48	51	1	80	4	8	27					404
Bird CB															
1959	40	17	24	26	17	11	–	–	2	–	–	–	–		137
1960	2	2	6	–	–	4	7	3	–	–	–	–	–		24
1961	–	–	–	2	–	8	–	–	2	–	–	–	–		12
1962	49	1	7	21	11	–	–	–	–	2	1	2	2		96
Total	91	20	37	49	28	23	7	3	4	2	1	2	2		269
Bird FH															
1955	13	6	20	15	7	13	16	10	7	17	7	5	5		141
1956	32	18	14	24	37	28	18	18	23	32	22	33	22		321
Total	45	24	34	39	44	41	34	28	30	49	29	38	37		462
Bird IN															
1955	–	–	7	14	–	–									21
1956	44	40	25	16	14	4									143
1957	8	1	19	2	7	–									37
Total	52	41	51	32	21	4									201
Bird IS															
1958	4	8	–	–	–	–	–	–							12
1960	33	–	28	15	22	17	11	–							126
1961	–	–	–	–	6	–	10	–							16
1962	11	–	10	13	11	14	12	26							97
Total	48	8	38	28	39	31	33	26							251

TABLE 10 (*Continued*)

Year	Number of songs of song pattern														Total songs
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Bird PH															
1955	9	–	–	–	–	–	–	–	–	–	–	–	–	–	9
1956	22	48	19	16	44	19	4	20	5	13	1	–	–	–	211
1957	4	–	4	3	–	8	10	1	2	21	–	4	6	2	65
Total	35	48	23	19	44	27	14	21	7	34	1	4	6	2	285
Bird PR															
1959	12	14	9	2	5	–	–	–	–	–					42
1960	25	8	12	3	–	6	1	–	–	–					55
1962	16	42	33	34	39	11	19	54	13	–					261
1963	6	4	4	11	10	8	6	–	6	4					59
Total	59	68	58	50	54	25	26	54	19	4					417
Bird WD															
1957	7	44	33	7	15	6									112
1958	1	28	16	1	14	8									68
1959	39	26	19	6	4	11									105
1961	17	20	26	–	10	26									99
Total	64	118	94	14	43	51									384

12, and 13 of FH), a bird's song pattern preferences may change from one year to another. On the other hand, one or more of a bird's patterns may be very uncommon each year (e.g., WD-4).

Constancy of song patterns.—In the majority of the 30 birds recorded more than one season, the songs of a given pattern were essentially similar from one year to the next; it was by this similarity that individual birds were identified. The song patterns of a Song Sparrow are remarkably fixed.

The principal differences in a song pattern from one year to the next were in the particular variations that appeared. In most cases some pattern variations were recorded one year but not in other years; FA represents an extreme in this respect. as all but 3 of its 71 song variations were recorded only one season.

A few birds showed minor differences in particular patterns from one year to another—in the presence or absence of certain notes or phrases, or in the character of certain notes or phrases. All 10 songs of FH-8 in 1955 (Table 10) had the trill immediately following the introductory phrases (I^{20} T^{3} . . .), while in 1956 all 18 songs of this pattern had an extra note between the introductory phrases and the trill (I^{20} B T^{3} . . .). Variations involving the presence or absence of certain notes or phrases were not unusual, and some-

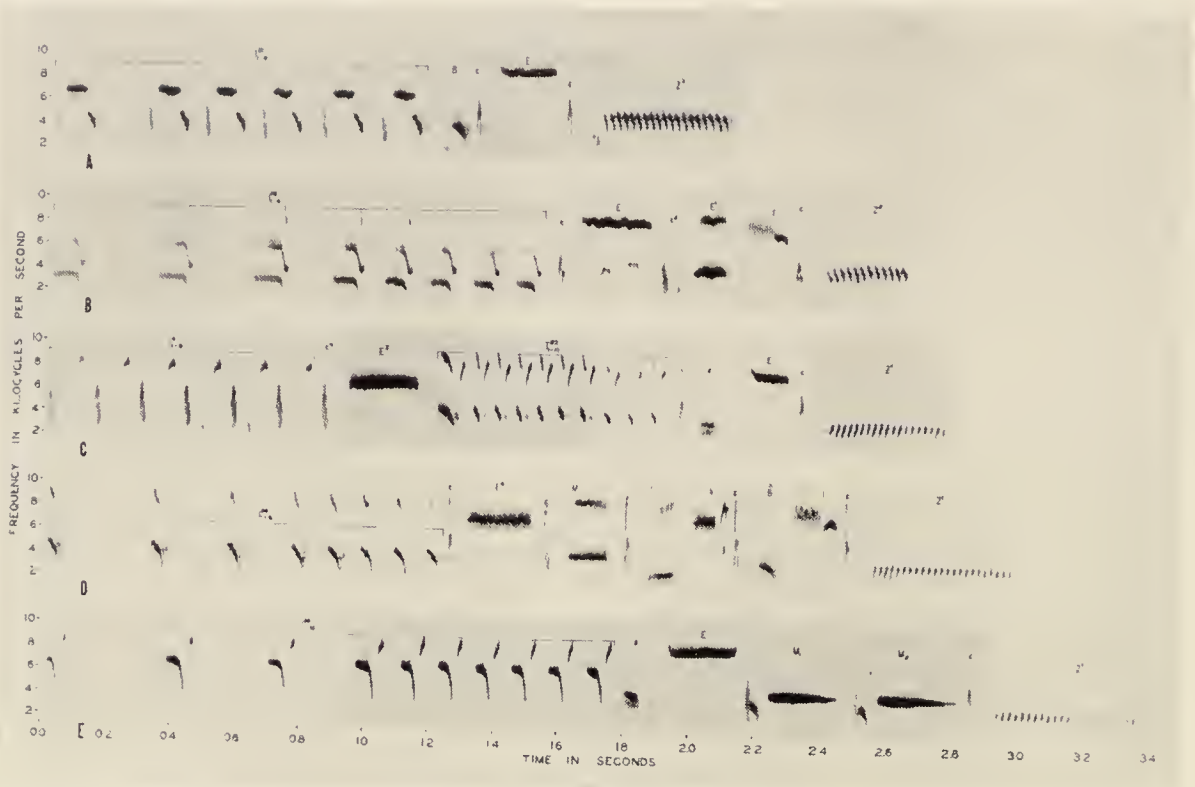

FIG. 6. Type 2 songs. A, WT-8C_6 (6067-45); B, PH-6C_8 (2858-2); C, IS-5$C_{6,10}$ (4898-3); D, BN-3B_8 (5347-11); E, FP-1A_{10} (6030-1). C is a Type 2 song containing a trill (T^{22}) following the introductory phrases.

times occurred in a single recording. There were a few patterns in which a particular note or phrase differed slightly in character in different years; such differences were relatively uncommon in a single season or recording. The songs of pattern BD-4 began with a single type of introductory phrase in 1958, but in 1960–62 began with two types (one the same type that was in the 1958 songs). One note of the introductory phrases of pattern CL-8 was longer in 1960 than in 1962. Several other similar variations from year to year might be mentioned, but all were minor, and most of them would not be apparent in the field. The outstanding feature of a Song Sparrow's song patterns is their constancy from year to year.

IDENTICAL SONGS OR SONG PATTERNS BY DIFFERENT BIRDS

The literature is somewhate contradictory on the question of whether or not different Song Sparrows may sing identical songs or song patterns. Saunders (1951:99) states that in his 884 song records of this species there was no case of two birds with identical songs. Mrs. Nice (1943:138) reports cases of certain songs from a number of birds, and mentions one (song J from bird 4M) as having been heard from at least 22 birds. Mulligan (1963) found a few cases of two birds, usually close neighbors, singing songs of the same

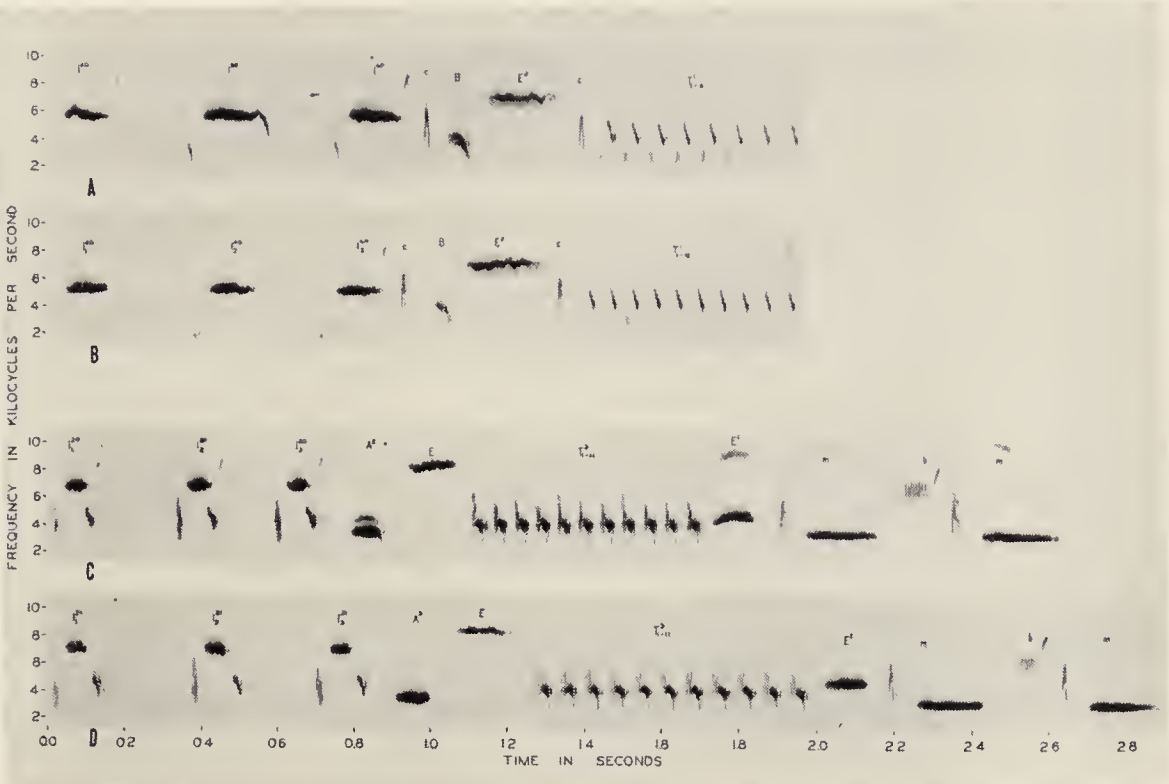

FIG. 7. Cases of songs by different birds that are nearly but not quite identical. A, BA-1R_8 (3504-9); B, PH-8A_{10} (2175-3); C, PH-9C_{11} (2822-3); D, SP-2A_{11} (2970-5). A and B are identical except for the difference in the second introductory phrase and the length of the trill; only a very careful listener would notice these differences in the field. C and D are identical except that the introductory phrases in D are three-noted, and lack the final high note present in the I^{20} phrases of C, and the note following the introductory phrases (A^2 in C and A^3 in D) is a little different; these differences are not apparent in the field.

"song types." The situation in the Maine birds studied was similar to that found by Mulligan.

Two songs by different birds may sound alike to the ear, but may actually be different as shown by the graphs; a number of instances of this sort were found in the Maine songs, two of which are illustrated in Fig. 7. Such differences may be due to the presence or absence of very short notes, differences in the number of trill phrases, or slight differences in the character of individual notes.

Song Sparrow *songs* by different birds are considered identical if they can be represented by the same letter formula, but determining whether or not *song patterns* by different birds are identical is not as simple. If identical songs by different birds are relatively complete, they are assumed to represent the same pattern: if they are short songs, they may or may not represent the same pattern, and to determine if the patterns are identical it is neeessary to examine the longer songs of these birds (if available). It is also possible

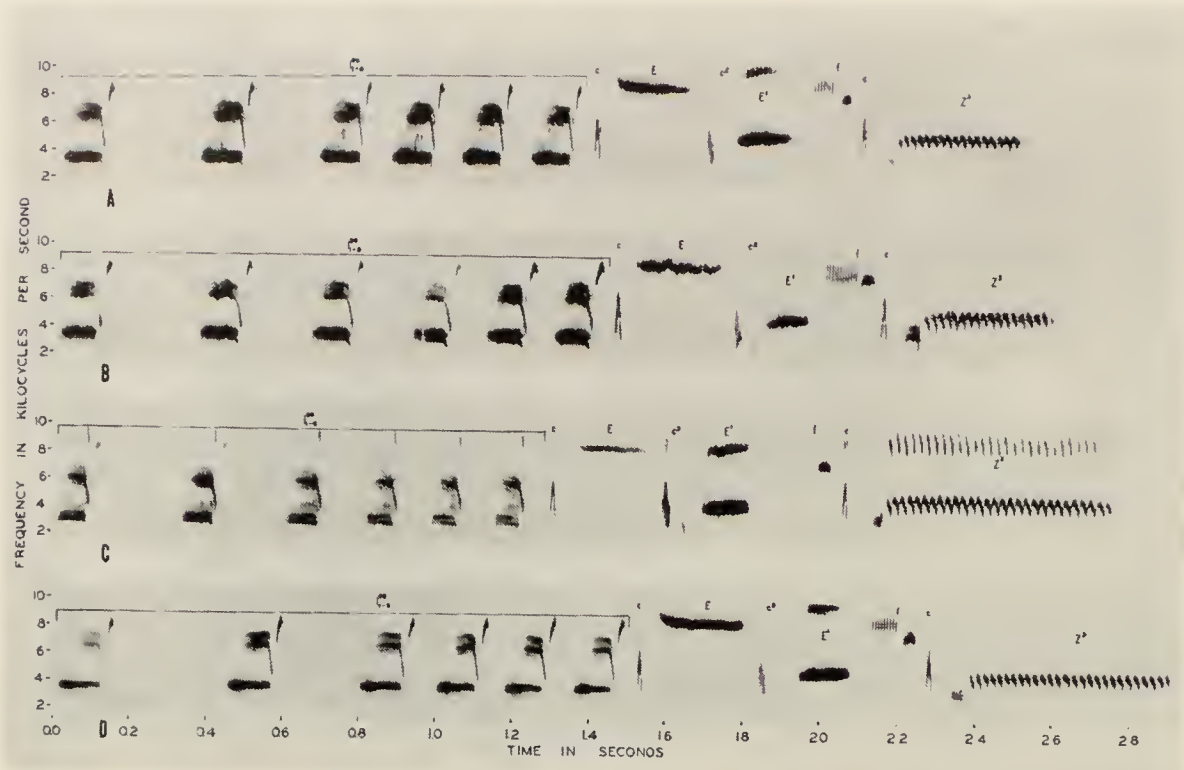

FIG. 8. Identical songs by four different birds: I_6^{99} *c E* c^2 E^1 *f c* Z^3. A, SS-7A_6 (6101-62); B, SQ-1B_6 (5477-1); C, BA-5B_6 (4308-46); D. IV-2F_6 (6113-18).

that two birds might sing songs of the same pattern that were not identical, but represented different variations of that pattern.

Thirteen cases of identical songs by different birds were found in the Maine songs: one involved a bird in the study area (DC) and another (FR) 6½ miles away, and the other 12 involved birds in the study area. Seven cases involved birds on Hog Island: one (Fig. 8) involved four birds, another (Fig. 9 A–C) involved three birds, and the rest involved two birds. The territories of most of these Hog Island birds were separated by 100 yards or more, or the birds were present in different years. Three cases involved birds on the Farm; one of these (Fig. 10 A–C) involved three birds, and the other two involved two birds (one of these is shown in Fig. 10 D–E); most of these Farm birds either had adjacent territories, or were present in different years. Two cases (one of which is shown by Figs. 6 E and 9 D) involved a bird on the Farm and another on Hog Island, from ¼ to ½ mile apart and recorded in different years.

One of the 13 cases of identical songs by different birds was the following:

I_{10}^{26} *a c* E^2 *M* ..... DC-1E_{10} and FR-1C_{10}

The longer songs of DC-1 and FR-1 were different:

I^{26} *a c* E^2 M_2 *c* Z^1 *x F* E^3 *N B* DC-1D

I^{26} *a c* E^2 M_2 T_1^5 *b c E* A^2 *f* FR-1A

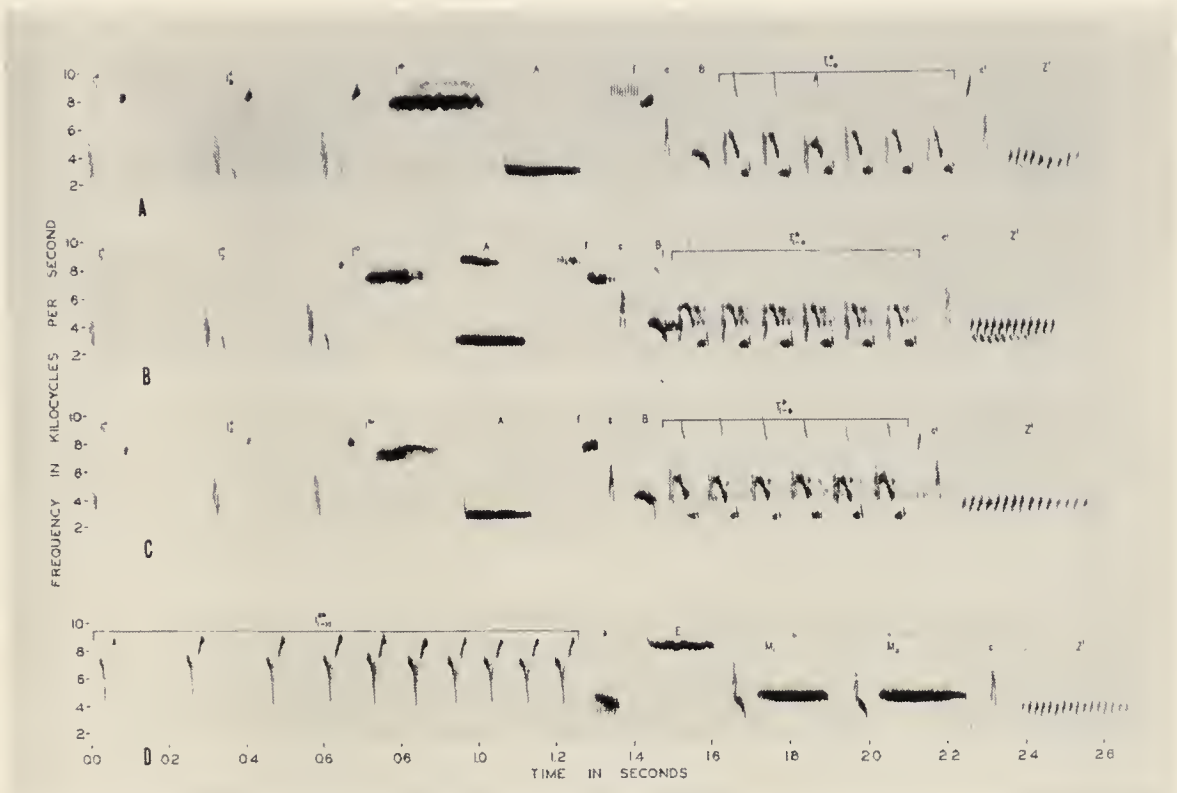

FIG. 9. A, B, and C, identical songs by different birds: $I_2^4\ I^{10}\ A\ f\ c\ B\ T_6^6\ c^1\ Z^1$; A, BD-7A (5395-13) ($T_3$ and Z^1 slightly distorted); B, PR-3A_6 (6037-1); C, WB-1A_6 (3501-4). D, a song by ND identical to one by FP: $I_{10}^{20}\ a\ E\ M_2\ c\ Z^1$; ND-4$A_{10}$ (2994-9); identical to FP-1A_{10} (Fig. 6 E).

Since the phrases beyond the *M* phrases in the longer songs of DC-1 and FR-1 were different, the patterns were considered different. Similarly, three other cases, of the 13 mentioned above, were considered to represent different patterns. Three cases were found in the Maine songs of two birds singing what were considered identical *patterns*, though identical *songs* were not recorded from the two birds of each pair.

Twelve instances were found in the Maine songs of what was considered the same *song pattern* sung by different birds; in nine of these cases there were identical *songs* by the different birds, and in the other three cases the songs of the different birds were considered different variations of the same pattern. Seven of the 12 instances involved birds on Hog Island whose territories were fairly well separated, or the birds were present in different years (or both). Four instances involved birds on the Farm whose territories were either adjacent, separated by 100 yards or more, or the birds were present in different years. One case involved a bird on Hog Island and another on the Farm, ½ mile apart and recorded in different years.

In practically all the cases of identical songs or song patterns sung by different birds, the birds involved were members of what may be considered the

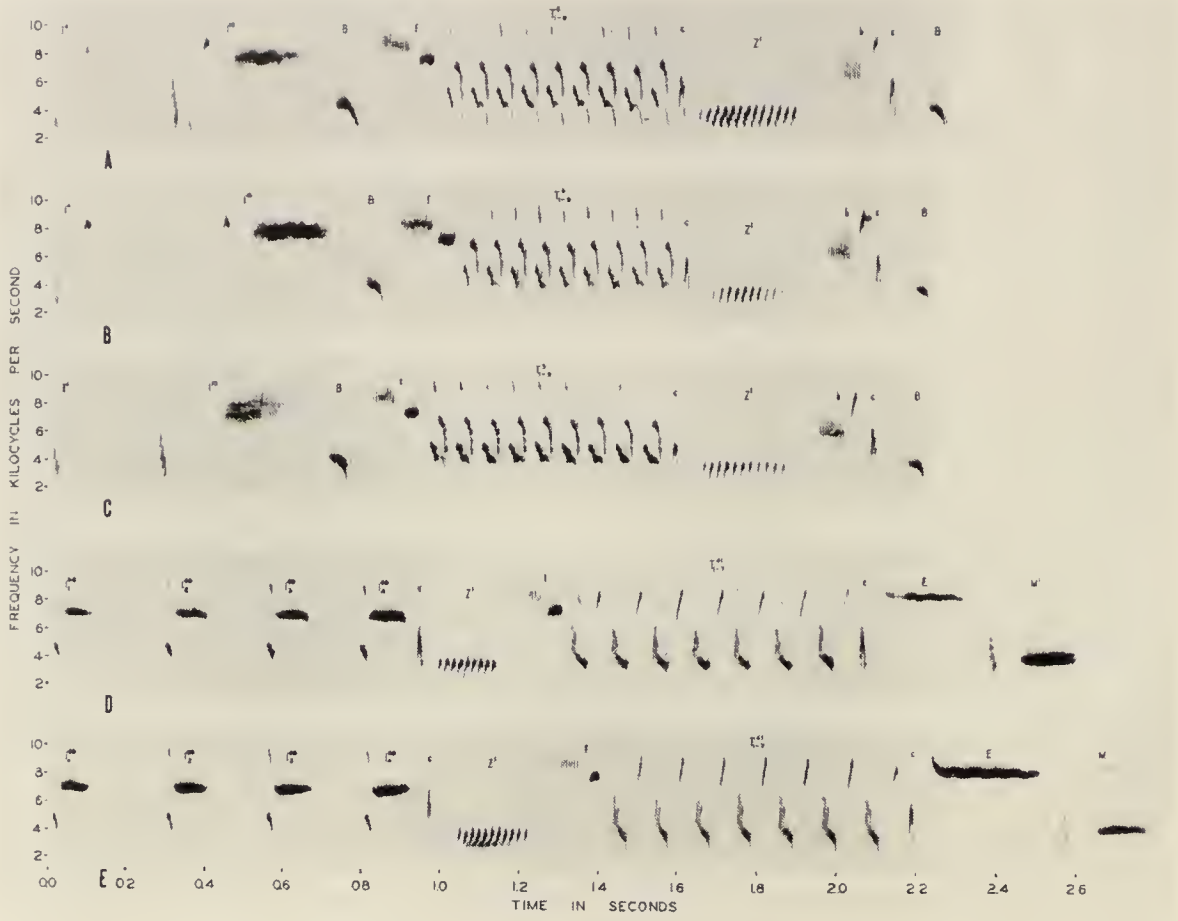

FIG. 10. Two cases of identical songs by different birds. A, B, and C, $I^{t}\ I^{10}\ B\ f\ T^{5}_{9}\ c\ Z^{1}\ b\ c\ B$; A, MO-1B$_{9}$ (4842-3); B, NC-5A$_{9}$ (5371-11); C, NR-3A$_{9}$ (6120-6). D and E, $I^{08}_{4}\ c\ Z^{1}\ f\ T^{11}_{7}\ c\ E\ M^{1}$; D, NG-6A$_{7}$ (6483-43); E, NM-5A$_{7}$ (6089-25).

same population (birds on the study area); in only one case (DC-1E$_{10}$ = FR-1C$_{10}$) were the birds involved very far apart (about 6½ miles), and this case involved identical short songs of different song patterns. It is likely that the only cases of two or more Song Sparrows singing the same songs or song patterns will be birds in the same general area.

SUMMARY

This study is based on an analysis by means of a sound spectrograph of 7,212 tape-recorded songs, of 120 birds; 6,645 of these songs, of 77 birds, were recorded in a 40-acre study area in Muscongus Bay, Lincoln Co., Maine; the rest were recorded elsewhere in Maine, at distances of ½ to 112 miles from the study area. The recordings were made over a period of 11 years, 1953–63.

Most songs began with two or more similar phrases; the remaining phrases varied considerably in different songs. The songs of a given bird that began with the same type(s) of introductory phrases, followed by approximately the same sequence of other phrases, were said to represent a given song pattern. The songs contained both musical and nonmusical notes; the musical notes were 0.04 to 0.25 second in length (rarely longer),

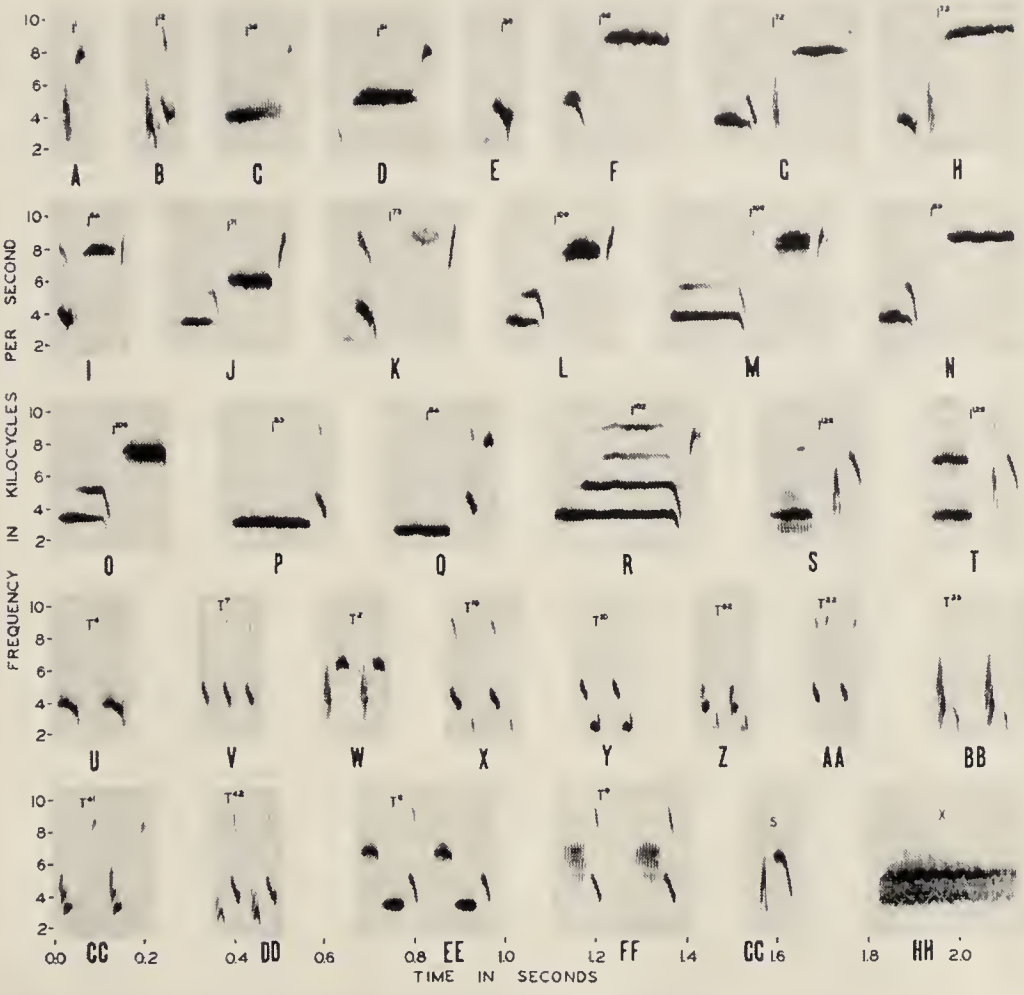

Fig. 11. A–T, introductory phrases; U-FF, trill phrases; GG and HH, other phrases. A, I^{1} (2994-2, ND-6); B, I^{12} (6482-2, NG-3); C, I^{39} (4757-3, MH-9); D, I^{51} (4886-11, IS-3); E, I^{66} (2994-17, ND-8); F, I^{68} (5458-2, SC-4); G, I^{72} (6035-1, DH-1); H, I^{72} (6523-22, MI-3); I, I^{64} (4343-3, BT-8); J, I^{71} (4891-1, CB-7); K, I^{73} (3674-2, MB-4); L, I^{109} (2970-32, SP-7); M, I^{109} (6512-7, FA-9); N, I^{69} (6109-4, CB-11); O, I^{106} (5958-1, IS-7); P, I^{83} (4220-1, BT-3); Q, I^{84} (3665-28, BD-4); R, I^{102} (6531-43, MT-5); S, I^{129} (4332-1, CB-3); T, I^{129} (4250-18, CB-3); U, two T^{1} phrases (2830-14, BA-4); V, three T^{7} phrases (2970-15, SP-4); W, two T^{2} phrases (2830-2, BA-2); X, two T^{10} phrases (4199-3, CB-6); Y, two T^{10} phrases (2211-58, PH-6); Z, two T^{62} phrases (6089-1, NM-1); AA, two T^{22} phrases (2164-1, PH-5); BB, two T^{35} phrases (6523-37, MI-5); CC, two T^{41} phrases (2994-17, ND-8); DD, two T^{42} phrases (6505-1, MA-7); EE, two T^{8} phrases (6505-3, MP-1); FF, two T^{9} phrases (4250-17, CB-2); GG, an S phrase (6491-25, NG-4); HH, an X phrase (2994-17, ND-8).

and were usually steady in pitch; the nonmusical notes were either very short and abruptly slurred, or buzzy. The buzzes were of three principal types, with modulation frequencies of 42–100, 145–165, and 300–335 per second.

The introductory phrases contained from 1 to 5 (average, 2.45) notes, and varied in number from 1 to 20. The song patterns found were classified into two types on the basis

of the number and spacing of the introductory phrases: Type 1, with 1–5 (usually 2–4) relatively evenly spaced introductory phrases, and Type 2, with 5–20 phrases in which the first two or three were usually slower than the rest. There was an increase in the rate of the introductory phrases through the series in most songs, and in all songs the first introductory phrases averaged 1.15 times as long as the last ones. The first introductory phrases were uttered at rates of 1.96 to 7.69 (average, 2.98) per second, and were faster in Type 2 than in Type 1 songs; the final introductory phrases were uttered at rates of 1.56 to 12.50 (average, 3.42) per second, and were faster in Type 2 than in Type 1 songs.

The Maine songs studied contained 544 song patterns, of which 473 (86.95%) were of Type 1, and the remainder of Type 2. A trill (a series of similar phrases uttered at rates of 6 to 25 per second) occurred beyond the introductory phrases in at least some songs of 410 patterns (75.37%), 387 (81.82%) of Type 1 and 23 (32.39%) of Type 2; 15 patterns contained two trills, and in 2 patterns the trill consisted of two slightly different phrase types. The number of phrases in the trills varied from 0 (pattern variations lacking the trill) to 26; the average maximum number was 9.40 ± 0.14. In 76 patterns the trill was immediately following the introductory phrases, in 167 it was 1–3 phrases after the trill, and in 178 patterns it was later in the song; in 11 patterns its location varied in different variations of the pattern.

Buzzes termed *Z* buzzes, with modulation frequencies of 42–100 per second, and usually 0.25 to 0.50 second in length, occurred in 412 (75.74%) of the Maine patterns; their location, when present, varied.

A Song Sparrow starting a song may stop anywhere along a given sequence, even after the first phrase, but most songs were at least 2 seconds in length, and the majority were 2.5 to 3.0 seconds in length; a few were as long as 4.0 seconds. The normal singing rate averaged 5.2 ± 0.1 songs per minute; when a bird was stimulated by playbacks, its singing rate averaged 8.2 ± 0.1 songs per minute.

Most of the phrases in the songs of the birds in the study area occurred in the songs of different birds. For 25 of the most common phrases of the study area birds, the incidence was less outside the study area than in it, and in general the farther away from the study area one goes, the less common the phrase was. The Song Sparrow thus exhibits what might be termed local dialects, suggesting that the various phrases of the song are learned by listening to other birds.

The birds that were represented in the recordings by a substantial number of songs had vocabularies of from 26 to 51 phrases, and averaged about 40. These were variously combined to produce a number of different song patterns. The following variations were found in the songs of a given pattern: in (1) the number of introductory phrases, (2) the type of introductory phrases, (3) the occurrence of a trill beyond the introductory phrases, (4) the number of trill phrases, (5) the location of the trill in the song, (6) where, along a given sequence of phrases, the song ended, (7) the presence or absence of certain phrases other than trill phrases, (8) the sequence of a few phrases, (9) the number of phrases other than introductory and trill phrases, (10) the character of individual phrases, (11) the ending of the song, (12) the length of some notes, and (13) the relative loudness of particular notes.

The repertoires of the birds studied varied up to 14 patterns; one bird had 14 patterns, two had 13, two had 12, and two had 11. In 53 birds represented by at least 50 songs or 6 song patterns, the repertoires ranged from 5 to 14 song patterns (average, 8.04) and 14 to 190 total variations (*different* songs) (average, 60.5). In ten birds represented

by 200 or more songs, the repertoires averaged 9.9 song patterns and 132.3 different songs per bird.

Thirty of the Maine birds were recorded in two or more years (one was recorded in 6 years), and these birds' song patterns were remarkably constant from year to year. Once a song pattern is developed by a bird, it remains in the bird's repertoire the rest of its life. Some patterns are sung relatively rarely.

Thirteen cases were found in the recordings studied of identical songs by different birds: one by four birds, two by three birds, and the rest by two birds. Four of these appeared to be instances of short variations of different patterns; the other nine appeared to be instances of identical song patterns. Three other instances were found of what appeared to be songs of the same pattern sung by two different birds, but the particular variations in each instance were different. Most of the cases of different birds with identical songs or song patterns were of birds relatively close together (on the study area); one case of identical songs by two birds involved birds about 6½ miles apart, and the songs appeared to be short variations of different patterns.

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DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO, 22 FEBRUARY 1964

SUN-ORIENTED DISPLAY OF THE ANNA'S HUMMINGBIRD

William J. Hamilton III

The male Anna's Hummingbird (*Calypte anna*) executes a remarkable display which involves a nearly vertical power dive over the display object. A pinging noise made by the tail and a brilliant display of the iridescent purple-red feathers of the chin and forehead presumably enhance the display value of this performance. This display is given in all months of the year, but is most frequent from November to April, the breeding season of this California species. These hummingbirds are highly territorial (Pitelka, 1951*a*) and this display dive takes place only within the territorial confines.

The diving display proceeds as follows (Fig. 1):

1. The male climbs nearly vertically (A to B), in a hovering flight with the head bent downwards and the bill pointed towards the display object so that the male appears to be eyeing the display object as he ascends.
2. The male stops in midair (B), 100 to 150 feet above and to the side of the display object. At this point the bird hovers, making no appreciable lateral movement, so that his azimuth with respect to the display object is no longer adjustable.
3. Almost at once the male power dives, with a burst of wingbeats, each burst terminating with the wings held to the sides. Several power bursts take place in the downward dive which is made at an angle of perhaps 65 to 75 degrees from the horizontal (B to C).
4. The flight levels (C) several feet from the display object (E) and the male passes over this object almost horizontally.
5. At the moment the bird is over the display object (D) the tail is lowered, and by some manipulation, as yet poorly understood, the tail produces a sharp report.
6. At this point the flight is slowed, the bird veers upward, rises in a hook-shaped course 10 to 15 feet above and beyond the display object, and hovers at this position (F) momentarily.
7. He then moves upward again (F to B) to approximately the same position where the initial dive started and a new dive is executed. The number of dives is variable, from one to a dozen or more, frequently from three to eight.

When I first witnessed this display on 28 March 1956, in a residential area in Berkeley, California, I noticed that the dive oriented directly into the afternoon (1714–1755) sun. Between that date and December 1963, I have had opportunity to witness several hundred additional dives, all oriented toward the sun when the sun was directly visible to me. During periods of

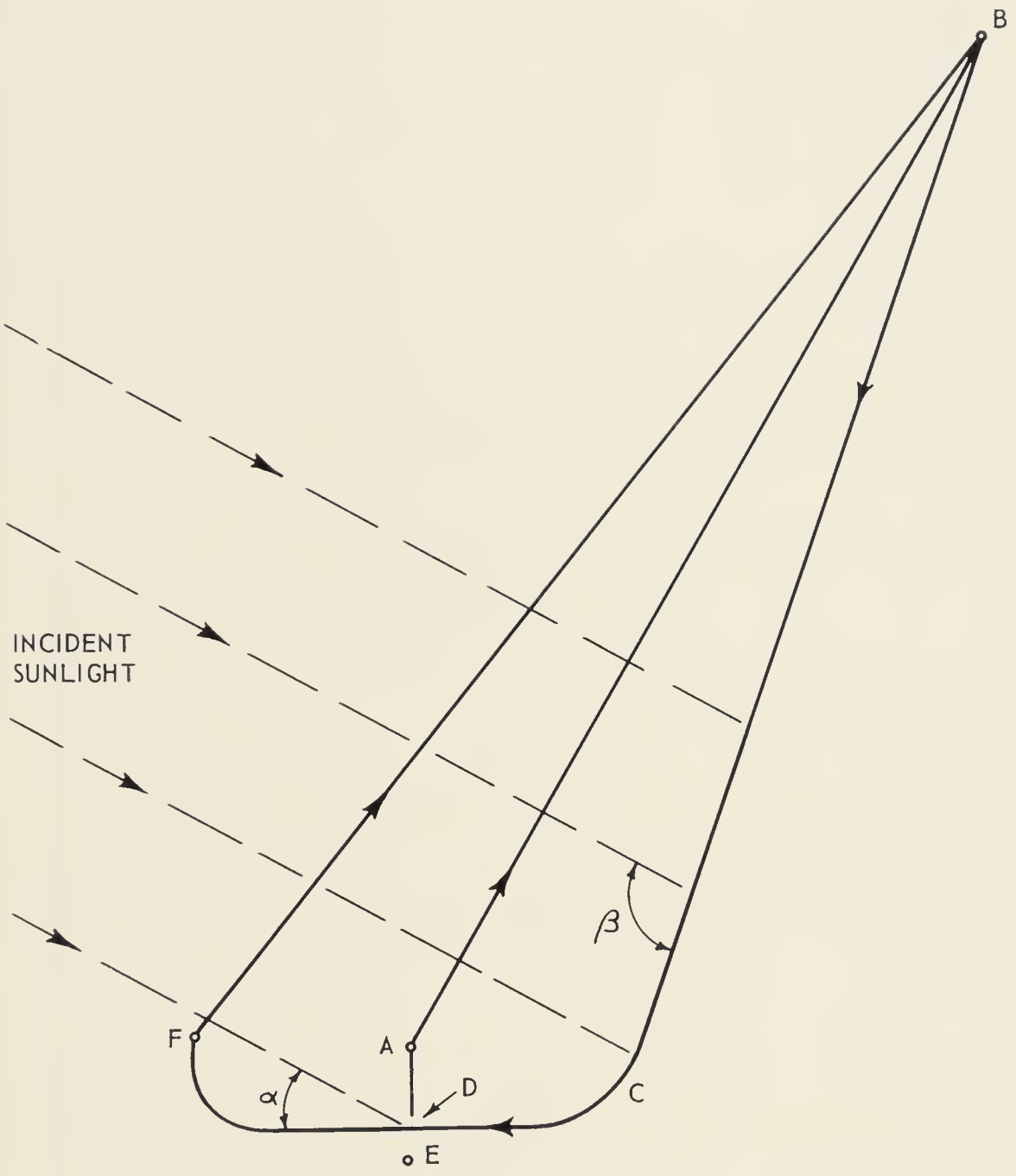

FIG. 1. Schematic lateral view of the display dive of the Anna's Hummingbird. This diagram is not drawn to scale; the actual distances and angles have not been accurately measured.

heavy overcast the dives are randomly oriented, but usually there is little display activity on such overcast occasions. Poor weather in general slows the display dive tempo of the Anna's Hummingbird. On 10 January 1964, at 1220, I was in the Japanese Tea Garden in Golden Gate Park in San Francisco. The day was almost completely overcast, the result of a low stratus formation. No clear shadows could be distinguished, but the location of the sun was

clearly discernible. A male Anna's Hummingbird was heard displaying several times, and when I managed to locate him he dived so that the horizontal part of the flight was oriented almost directly *away from* the sun.

Display dives are usually directed at some fixed identifiable object, such as another hummingbird, male or female, or some other species of bird intruding into the territory such as the thrush, *Hylocichla guttata*, or even a man. Since this stimulus object triggers the dive, the dive has a double azimuthal orientation, being horizontally oriented with respect to the stimulus object and the sun. The sun orientation, therefore, must be made during the upward (A to B and F to B, Fig. 1) flight. There seems to be little if any azimuthal deviation during the downward dive. Loye Miller tells me that he has seen a horizontally kinked course during the dive. It seems likely that such deviation of the course is made relative to the stimulus object rather than the sun. I have never seen a dive pass to the side of the stimulus object.

Occasionally no stimulus object is apparent. Pitelka (1942) suggests that these displays may be triggered by other singing or displaying males nearby. In these instances the dive passes over the singing post, and for our purposes in evaluating the directional component of the dive the singing post may be considered the display object.

While the downward flight is usually quite precisely oriented to pass directly over the display object, it is not always oriented absolutely into the sun. If the performance is viewed from the side, as is usually the case, one can only say that the dive is oriented in the general direction of the sun. On 14 January 1962, I heard two pings from dives outside my office window of the California Academy of Sciences in Golden Gate Park, San Francisco. From "field" notes taken then:

"The male climbed away from the sun with respect to the female. During dives 3 through 7 (the first 2 were heard only) I could accurately line up his position over the cornice of the building. The third dive passed directly over the female and slightly to the left of the sun. Each successive dive through the seventh started slightly further counterclockwise with respect to the female, so that the seventh dive was oriented about ten degrees to the right of the sun. The eighth through the eleventh dives started behind the building at a point I could not see, but they apparently continued the circling trend. Each of these nine dives went directly over the female with the usual ping."

On 20 and 21 April 1956, Jay Schnell and I placed a mounted male and female Anna's Hummingbird in the territory of a male Anna's Hummingbird at Arlington, in the hills above Berkeley, California. On several occasions this male dived at the wired male while I held the attachment wire in my hand. In this circumstance the orientation of the dive was easily determined, and the effect of the dive could be more fully appreciated from

this vantage point. The effect is one of a tiny ember, suddenly descending upon the observer, growing in brilliance and dimension as it approaches, to burst with a pop as it passes over the display object. If the object is not alert to this hummingbird prior to the first dive, there is little likelihood that a series of these performances could be ignored.

The Allen's (*Selasphorus sasin*) and Rufous (*Selasphorus rufus*) Hummingbirds, which have similar display dives, have no consistent orientation with respect to the sun. In the course of mounting to the point of initiation of the dive these birds fly upward, with the bill forward. This contrasts with the helicopter-like rise of the Anna's Hummingbird from A to B or F to B (Fig. 1) which is made with the head continuously oriented towards the display object. At point B these *Selasphorus* species make a sharp sweeping turn and plunge. These species are more erratic in the course of the downward descent, with frequent sharp turns in the flight course. These comparisons lend support to the suggestion that in the Anna's Hummingbird the orientation components are resolved in the course of the upward movement.

The significance of this sun orientation of the display would seem to be enhancement of the reflecting value of the iridescent gorget feather tips during this display. Greenewalt (1960) has pointed out that the effectiveness of iridescence depends upon: (1) the position of the observer with respect to the iridescent plumage and the sun; (2) the angle of placement of the microscopic components of the feathers; and (3) the position of the feathers on the body. The latter two factors will modify the first only to the extent that they will influence how critical the displayer–observer–sun relationship must be. Irrespective of the latter two, however, the display value of the performance will be enhanced by sunward orientation.

Among hummingbirds, analysis of the orientation of display dives suggests possible insight into ecological and evolutionary relationships. The maximal selective premium in terms of display value would be derived when the angle between the horizontal component of the dive and the direction of incident sunlight (angle α, Fig. 1) were closest to 0°. A zero value will be most closely approximated when (1) the breeding area is farthest from the equator, and (2) the season of display is closest to the winter solstice (21 December). Since the Anna's Hummingbird display falls in the winter months (Pitelka, 1951*a*, 1951*b*), the second requirement is near the maximal potential value for this species. The latitude of the breeding area of the Anna's Hummingbird, at 30–40° north, is well north of the breeding range of most hummingbird species.

These considerations do not, of course, explain the role of the vertical component (B to C) of these dives. For maximum reflection value the angle β in Fig. 1 would have to reach 0 as well, and random movements in and about

the display object would improve upon the approximate observed values for this component. Presumably then this aspect of the dive functions to generate with the aid of gravity, sufficient speed to make possible the ping which is made over the display object and is not related to display of the iridescent plumage. The actual mechanism by which the tail sound is produced has not been investigated.

It is possible that display dives, especially those which are sun oriented, may have opportunity to develop only in very open areas such as the coastal vegetative complex of California where the Anna's Hummingbird breeds. Especially in tropical understory vegetation these displays would be unlikely to develop. These considerations suggest that the Anna's Hummingbird, a resident species in California, has been in this region for a considerable period of geologic time, probably without recent gene flow to other populations or areas. At the present time there is little avenue for such gene flow; the species is almost strictly limited to California, but a certain level of hybridization with related species persists (Banks and Johnson, 1961).

Skutch (1940*a*) has distinguished two basically different types of display among hummingbirds, "dynamic" and "static." The dynamic type is exemplified by the Anna's Hummingbird display dive described here. In addition, it is characteristic of the Broad-tailed Hummingbird (*Selasphorus platycercus*) (Skutch, 1940*a*), the Black-chinned Hummingbird (*Archilochus alexandri*), Costa's Hummingbird (*Calypte costae*), the Rufous Hummingbird (*Selasphorus rufus*), Allen's Hummingbird (*Selasphorus sasin*), the Calliope Hummingbird (*Stellula calliope*) (Banks and Johnson, 1961), and the Ruby-throated Hummingbird (*Archilochus colubris*) (Pitelka, 1942), the most northerly representatives of the hummingbirds. Central American species such as the Reiffer's Hummingbird (*Amazilia tzacatl*), White-eared Hummingbird (*Hylocharis leucotis*), and Heloise's Hummingbird (*Atthis heliosa*) do not have prominent display dives but confine their display energy to singing and gorget flashing at display posts, the static display type (Skutch, 1940*a*, 1940*b*).

Experimental evidence quite clearly demonstrates that the oriented migration performance of caged Starlings (*Sturnus vulgaris*) is based upon the sun (Kramer, 1956). When the sun is behind clouds below the artificial horizon of the apparatus which tests the orientation ability of Blue-winged Teal (*Anas discors*), orientation fails (Hamilton, 1962). The sun-oriented display reported here, however, apparently breaks down with moderate levels of overcast under conditions when the migratory orientation would persist. It seems possible, therefore, that the display orientation performance may be based upon shadows. Certainly shadows could provide adequate cues since the stimulus object is invariably elevated, either in a bush or tree, and the observed orientation could be achieved by lining up along the extension of the

shadow of the stimulus object or its support. This hypothesis could be experimentally tested by shadow masking.

The orientation of bird displays with respect to the sun has received little attention. The Satin Bowerbird (*Ptilonorhynchus violaceus*) usually builds its display bower along a north–south axis and will correct the orientation of the bower if it is experimentally altered. Marshall (1954) suggests that "the utility of north–south orientation may be that very early each morning when energetic display begins, the male can keep the motionless female in view without staring straight into the rising sun. Likewise she can watch his flashing display without discomfort." However, at the season of display the sun rises in the northeast, so that bower orientation could be more appropriate with respect to Marshall's (op. cit.) suggestion, i.e., perpendicular to the northeast–southwest axis, the sun would apparently not enhance the display value of the male's iridescent plumage. This and the whole problem of the orientation of bird display with respect to the sun might be profitably studied on a comparative basis.

SUMMARY

The Anna's Hummingbird performs an aerial power dive display. The power dive passes over the display object and a sharp sound is made with the tail feathers. The bird then lofts high into the air to make repeated dives. The azimuthal component of this dive is always oriented into the sun when the sky is clear. This orientation enhances the display value of the iridescent plumage of the male with respect to the stimulus object.

Under overcast conditions the orientation of dives is no longer sun oriented. A single observation suggests that when bright shadows are lacking but the location of the sun is clear, orientation fails. This suggests the possibility that the orientation of the dive is based upon shadows.

A sun-oriented display is most likely to evolve in species which have iridescent plumage and breed at high latitudes or in the winter months. The Anna's Hummingbird meets all of these criteria and is, as far as is known, the only species of hummingbird which orients its display with respect to the sun.

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Zoology Department, University of California, Davis, California. 18 May 1964

NEW LIFE MEMBER

Burt L. Monroe, Jr. of Baton Rouge, Louisiana has recently become a Life Member of the Wilson Ornithological Society. Mr. Monroe is a graduate of the University of Louisville and will be a candidate for the doctoral degree at Louisiana State University in June of 1965. Long known among ornithologists as a most enthusiatic organizer and participant in Christmas Bird Counts in several parts of the United States, he has recently turned his interest to tropical birds and is currently preparing a book on the birds of Honduras. In addition to this book Mr. Monroe has published numerous articles in *The Wilson Bulletin*, *The Auk*, and other publications. He is a member of the Cooper Ornithological Society, The Kentucky and Louisiana Ornithological Society, the Society of Systematic Zoologists, the Lepidopterists Society as well as the American Ornithologists' Union for whom he is currently serving as chairman of the membership committee. He is married and has as a principal hobby, aviation, for which he holds a commercial license. The picture shows Mr. Monroe examining specimens taken on a recent collecting trip to Africa.

EFFECT OF WEATHER ON AUTUMN SHOREBIRD MIGRATION IN EAST-CENTRAL ILLINOIS[1]

William S. Brooks

The effect of weather on migration has been under study since the late 1800's, but even yet there is considerable disagreement among workers on this subject.

Cooke (1885*a*, *b*) was apparently the first to associate migration and weather, correlating spring movements with high temperature, low pressure, and, due to the low pressure, southerly winds and overcast. He surmised that conditions were reversed in autumn. Von Haartman and Bergman (1943) were able to correlate migration in Europe with pressure systems and cold fronts in autumn, but were not able to correlate increased intensity of southward migration and cold weather per se. Thomson (1953) and Mascher (1955) did not consider pressure important. Mascher (in Sweden) also considered changes in humidity, wind conditions, and atmospheric electricity in connection with passing fronts as unimportant, but thought that temperature was of greatest importance. Stolt (1959) in Scandinavia noticed "a close connection between falling temperature and intensified migratory movements." He found no correlation with variations in pressure, humidity, wind direction, and cloudiness. Svärdson (1953) stated that for "early migrants, e.g. waders, experience at Ottenby shows anticyclonic weather to be the worst 'bird weather' when the number of passing and resting birds is at its minimum. Later in the season anticyclonic weather more often gives numerous birds." Trowbridge (1902) thought it probable that many birds use the wind as a physical agent in migration. Lack (1960) supposed that "while migration is more common with following than opposed winds, this is normally due to other associated weather factors." Later (1962, 1963) he reversed his opinion and considered wind direction important. Hassler et al. (1963) attributed importance in the Midwest in autumn to a clockwise wind shift from south to north as a stimulus to migration. Although this is usually associated with the passage of a cold front, they felt that the wind shift was the primary factor. The occurrence of autumn migration with cold fronts has been pointed out by many workers, among them Bennett (1952) in the Midwest. Hinde (1951) suggests an interaction between internal factors of the bird (its physiological state) and weather factors in such a way that the influence of each weather factor probably varies with each of the others and with the state of the internal factors. Perhaps the apparent lack of agreement

[1] This paper is a revised portion of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Scienee at the University of Illinois.

among different workers concerning the effect of weather on migration can be explained in part by what Hinde has suggested, and in part by the fact that birds in different regions may react differently.

The present study reports on work conducted from 10 September to 5 November 1960 and 1 July to 5 November 1961 at a small shallow pond approximately ¼ mile north of Champaign, Illinois. This pond was apparently a concentration point for shorebirds, since it was one of few in the area which contained sufficient available food and feeding space for these birds. The 20 species which were recorded during the two migrations are: Semipalmated Plover (*Charadrius semipalmatus*), Killdeer (*Charadrius vociferus*), American Golden Plover (*Pluvialis dominica*), Black-bellied Plover (*Squatarola squatarola*), Common Snipe (*Capella gallinago*), Spotted Sandpiper (*Actitis macularia*). Solitary Sandpiper (*Tringa solitaria*), Greater Yellowlegs (*Totanus melanoleucus*), Lesser Yellowlegs (*Totanus flavipes*), Pectoral Sandpiper (*Erolia melanotos*), Baird's Sandpiper (*Erolia bairdii*), Least Sandpiper (*Erolia minutilla*), Dunlin (*Erolia alpina*), Short-billed Dowitcher (*Limnodromus griseus*), Stilt Sandpiper (*Micropalama himantopus*). Semipalmated Sandpiper (*Ereunetes pusillus*), Western Sandpiper (*Ereunetes mauri*), Buff-breasted Sandpiper (*Tryngites subruficollis*). Sanderling (*Crocethia alba*), Wilson's Phalarope (*Steganopus tricolor*).

METHODS

Observational data were obtained by recording species and numbers of shorebirds seen on irregularly spaced trips usually made once a week, and during the height of migration, several times a week. Observations were usually made at about 0700 hours CST, but often trips were made later in the day, and sometimes morning and afternoon trips were made on the same day.

Weather data were obtained from Chanute Air Force Base, Rantoul, Illinois, about 15 miles north of Champaign, and from the Illinois State Water Survey in Champaign. The five weather conditions considered most important and most readily comparable with migration in this study are: the passage of cold fronts, a clockwise wind shift toward north, the occurrence of precipitation, and falling daily maximum and minimum temperatures.

Periods between observations (2.3 day average, 5 days absolute maximum used in the calculations) were given a + or – rating for each weather condition, depending upon whether the condition occurred or not. Numbers of individuals moving into or out of the pond were totaled separately for + and – periods, and the chi-square test was applied. For each weather condition the mean number of birds migrating for + and – periods was computed. The two means were then summed and the percentage for the mean of the + period

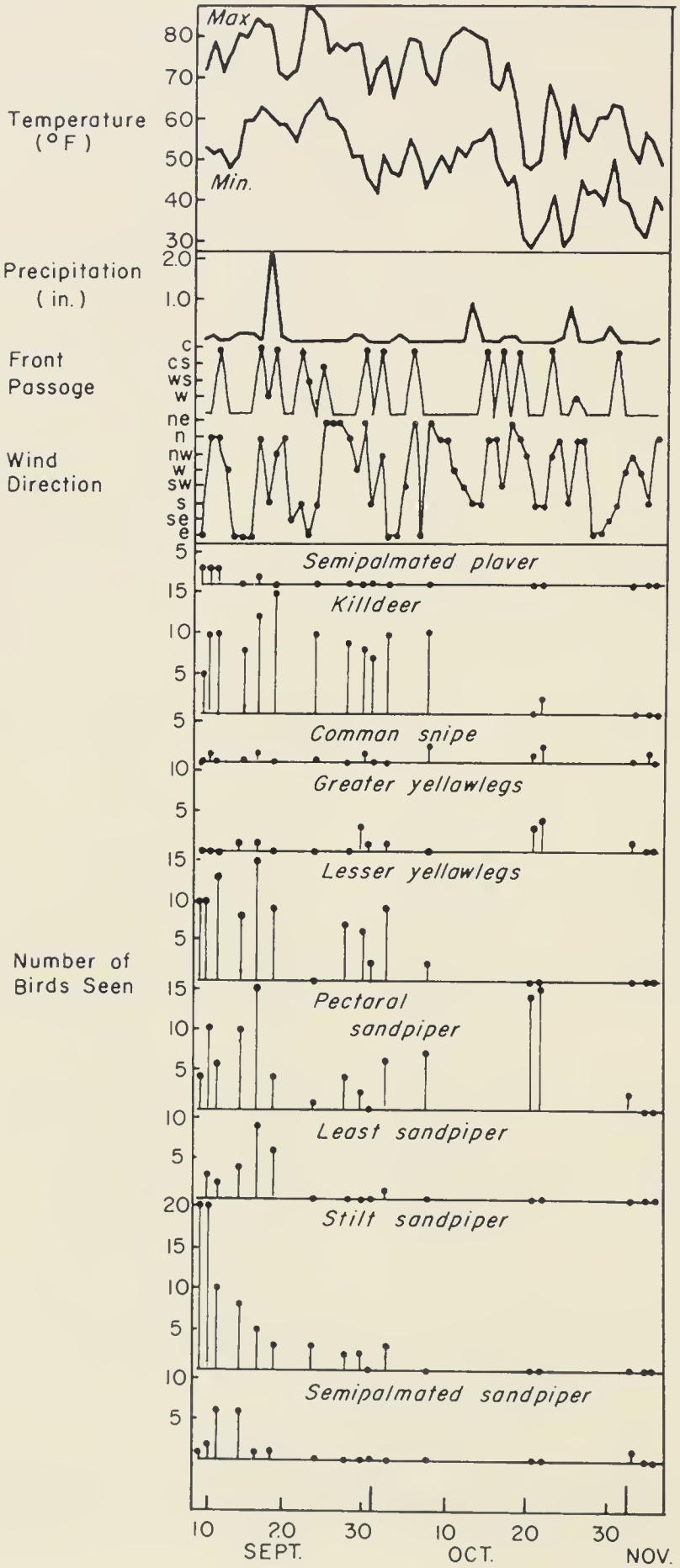
TABLE 1
FALL MIGRATION DATA, 1960, 1961

Species	Arrival	Departure	Peak date(s)	Peak No.
		1960		
Semipalmated Plover	–	17 Sept.	–	–
Killdeer	–	22 Oct.	19 Sept.	15
Golden Plover	8 Oct.	8 Oct.	8 Oct.	1
Black-bellied Plover	19 Sept.	8 Oct.	19 Sept., 8 Oct.	2
Common Snipe	–	4 Nov.	8, 22 Oct.	2
Greater Yellowlegs	–	2 Nov.	22 Oct.	4
Lesser Yellowlegs	–	8 Oct.	–	–
Pectoral Sandpiper	–	2 Nov.	–	–
Least Sandpiper	–	3 Oct.	–	–
Dunlin	2 Nov.	2 Nov.	2 Nov.	5
Stilt Sandpiper	–	3 Oct.	10, 11 Sept.	20
Semipalmated Sandpiper	–	2 Nov.	–	–
Buff-breasted Sandpiper	–	10 Sept.	10 Sept.	2
		1961		
Semipalmated Plover	24 Aug.	13 Sept.	31 Aug.	8
Killdeer	9 July	4 Nov.	17–19 Sept.	20
Golden Plover	8 Oct.	8 Oct.	8 Oct.	2
Black-bellied Plover	24 Aug.	31 Aug.	31 Aug.	2
Common Snipe	5 Sept.	29 Oct.	14 Oct.	8
Spotted Sandpiper	9 July	7 Sept.	9–16 July	5
Solitary Sandpiper	3 Aug.	17 Sept.	17 Aug.	6
Greater Yellowlegs	3 Aug.	4 Nov.	24 Oct.	13
Lesser Yellowlegs	16 June	14 Oct.	7 Sept.	125
Pectoral Sandpiper	10 July	14 Oct.	3 Sept.	50
Baird's Sandpiper	17 Aug.	19 Sept.	3 Sept.	3
Least Sandpiper	9 July	13 Sept.	3 Sept.	35
Dunlin	24 Oct.	29 Oct.	24 Oct.	8
Short-billed Dowitcher	16 July	13 Sept.	3 Sept.	4
Stilt Sandpiper	8 Aug.	19 Sept.	13 Sept.	20
Semipalmated Sandpiper	8 Aug.	17 Sept.	5 Sept.	21
Western Sandpiper	3 Sept.	13 Sept.	13 Sept.	3
Sanderling	24 Aug.	5 Sept.	31 Aug.	6
Wilson's Phalarope	12 July	5 Sept.	12 July 5 Sept.	2

was determined. This value is used as the per cent correlation of migration with the weather conditions in Figure 3.

RESULTS AND DISCUSSION

All species apparently reacted in a similar manner to weather conditions. and therefore are discussed collectively below. An idea of the number of birds


Temperature (°F)
Max.
Min.
80
70
60
50
40
30
Precipitation (in.)
2.0
1.0
0
Front Passage
c
cs
ws
w
Wind Direction
ne
n
nw
w
sw
s
se
e
Number of Birds Seen
Semipalmated plover
Killdeer
Common snipe
Greater yellowlegs
Lesser yellowlegs
Pectoral sandpiper
Least sandpiper
Stilt sandpiper
Semipalmated sandpiper
10
20
30
SEPT.
10
20
30
OCT.
NOV.

involved can be ascertained from Table 1. Figures 1 and 2 show the observational data obtained for the more common species, with weather data added for comparison. The correlations shown in Fig. 3 are derived from data for all species. Fifty per cent correlation indicates that half of the birds moved when the designated weather condition was present, and half moved when it was not present, hence there is no significant correlation with that condition. A correlation value significantly ($p \leqslant 0.02$) below 50% indicates that migration was inhibited or at least not favored by that condition. A value significantly above 50% indicates that migration was favored and, in fact, was initiated when movement out of the area occurred.

The correlations with the movements out are considered the most accurate, since the starting point of the birds and the weather conditions at that time are both known, whereas they are not known for movement in. Therefore, the discussion below concerns only movements out.

In general, migration was positively correlated more highly with wind shifts toward north, cold fronts, and precipitation than with the other two conditions (Fig. 3). In every period of time where comparisons were made, correlations with wind were greater than with cold fronts or precipitation, although not always significantly greater. Correlation with cold fronts and precipitation was essentially equal.

Precipitation was positively correlated with migration at all times except during the first half of migration in 1961, when there was no correlation (Fig. 3*e*). The effect on migration, however, was probably indirect. Since the pond had no outlet, rain caused the water level to rise, and with a small rise in water level a disproportionately large area of the gently sloping pond edge was covered. Feeding areas and food availability were both reduced and the birds left the area. During the warmer months the water level did not rise as much as it did later in the season, with a comparable amount of precipitation because of higher evaporation and because the dryer soil took up more water. The data support an indirect effect of precipitation on migration here, since there was no correlation during the first half of migration (warmer months) in 1961 when rain caused very little rise in water level.

Positive correlation with falling maximum temperature never occurred. Negative correlation occurred in the last half of 1961 (Fig. 3*e*, *f*), and in 1960–61 combined (Fig. 3*c*), but in all other instances there was no significant correlation in either direction. These data suggest that in some cases migra-

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Fig. 1. Autumn migration of the more common shorebirds, 1960, and weather conditions. Front designations: c, cold front; cs, stationary cold front; ws, stationary warm front; w, warm front.

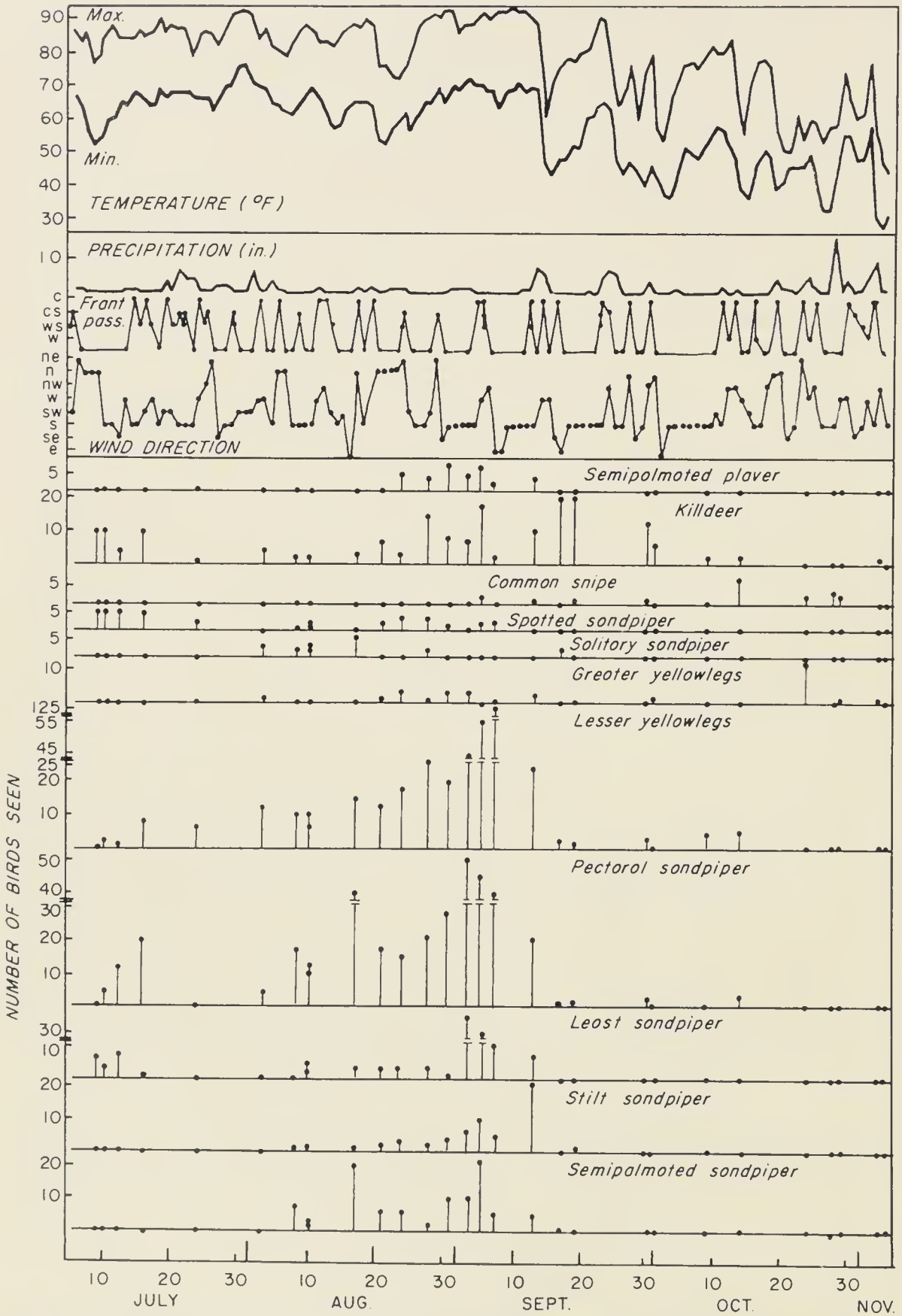

FIG. 2. Autumn migration of the more common shorebirds, 1961, and weather conditions.

tion is inhibited by a falling trend in daily maximum temperature, but the validity of this observation is questionable. Probably falling maximum temperature has no effect on migration.

Falling minimum temperature was not significantly correlated with migration in 1960, 1961 (Fig. 3*a*, *b*, *d*), or in the first half of migration in 1961. However, there was significant positive correlation in the last half in 1961. In general, temperature drops during the warmer months were not as great, and additionally occurred at a higher initial temperature than those during the cooler months. Most significant temperature drops occurred with the passage of a cold front, but not with all fronts, especially those coming earlier in the season. Therefore, since migration was positively correlated with falling minimum temperature only in the last half of 1961, it seems possible that this condition has some importance later in the migration period. If this is true, temperature may have a gradual cumulative effect, much like that postulated by Weise (1956) for the spring migration of three species of sparrows (but, of course, cumulative in the opposite direction). It is possible then, as Hinde (1951) suggested, that the relative importance of any weather factor varies with other factors. It is also possible, that since temperature drops were generally concurrent with cold fronts, the birds were actually responding to the fronts or to the wind shift accompanying them. In this case the influence of falling temperature would mask the actually higher relative importance of the other factors.

The data appear to indicate that a clockwise wind shift toward north is the primary or even sole weather stimulus to continuing migration for shorebirds in the Midwest, supporting the suggestion of Hassler et al. (1963) concerning passerines. Although correlation with cold fronts was high, that with wind was higher in all cases. Since such a wind shift occurs almost always when a front passes (but sometimes it occurs without frontal passage), cold front passage may have a masking effect on the relation, like that of temperature discussed above. That is, the birds appear to be responding to a cold front when it passes, but they are in actuality responding to the wind shift accompanying it. This is illustrated by the fact that in October 1960 the mean number of birds migrating during the two periods when cold fronts passed without a wind shift was 3.5, while the mean for birds migrating in the two periods with a wind shift but no front was 5.0. The overall volume of migration in October was higher during the time of the two former periods than when the two latter periods occurred. Thus, percentagewise these two means are actually more different than they appear as absolute figures.

Frequently there were times when the number of various species did not change from one observation to the next (see Figs. 1 and 2). It is assumed that this indicated no migration, although it is possible that movement out

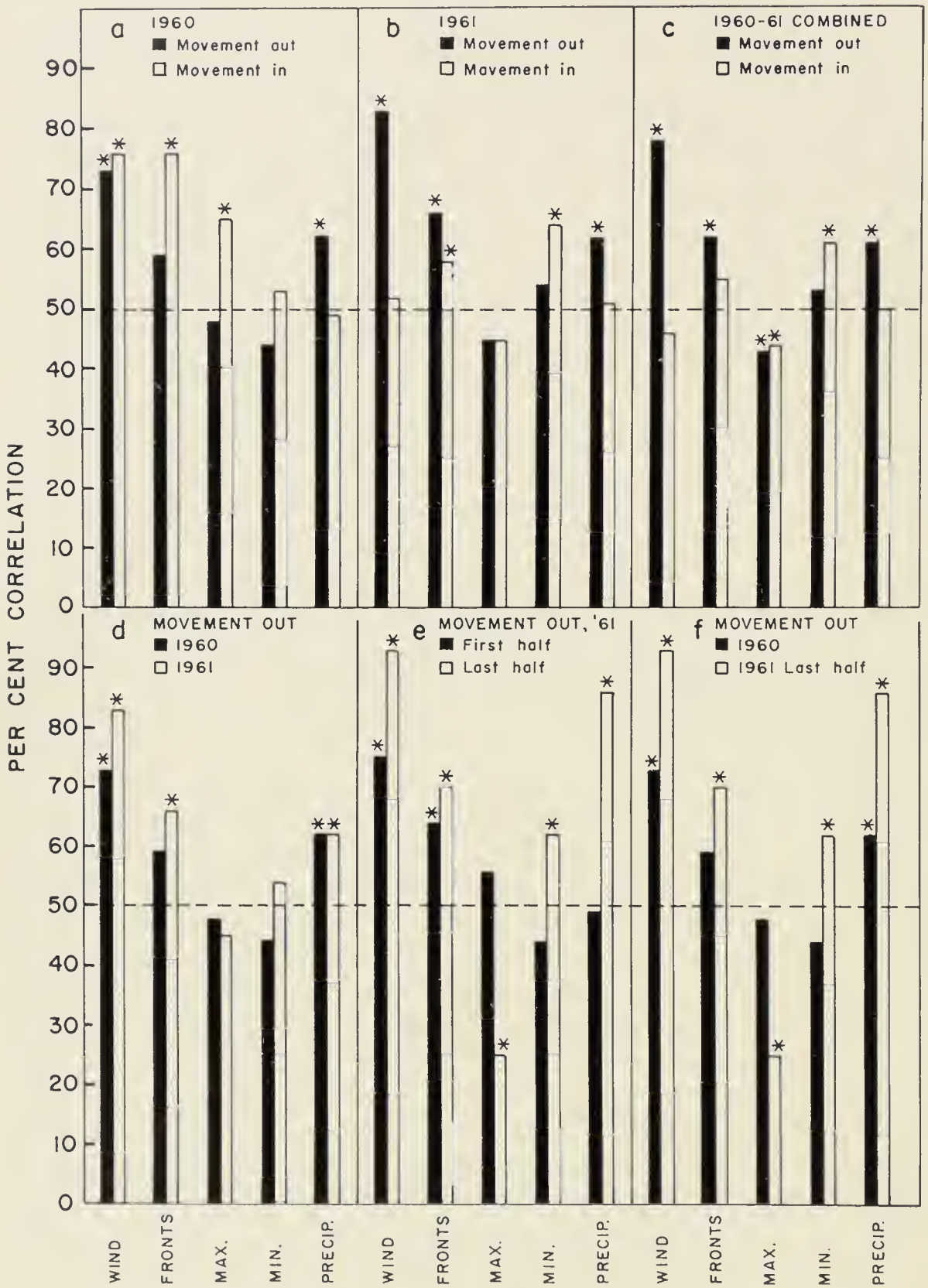

FIG. 3. Per cent correlation between autumn migration of shorebirds and wind shifts toward north, cold fronts, falling daily maximum and minimum temperatures, and precipitation. Starred bars indicate significant positive or negative correlation ($p \leq 0.02$), depending on whether the value is above or below the 50% line.

compensated exactly for movement in. Of the periods when birds showed no movement the following was determined:

a) wind shift toward north occurred in 75%;
b) cold front passage occurred in 70%;
c) precipitation occurred in 63%;
d) falling minimum temperature occurred in 37%;
e) falling maximum temperature occurred in 34%.

This may indicate that the birds must be physiologically ready to migrate, and unless they are, weather conditions have little influence.

The amount of time that birds remained at the pond varied from 1 to probably about 12 days (possibly 20 days or more for certain Stilt Sandpipers in 1960). The durations were determined by examination of the movements (Figs. 1 and 2) and by observations made on certain individuals with distinctive markings (e.g., one, a slightly melanistic Lesser Yellowlegs). The average stay for several of these individuals was 5 days, but it is probable that the average for all birds was somewhat less. A combination of factors probably determined the length of the stay, including weather conditions, the internal state of the birds, and feeding conditions.

Very little correlation could be attempted between other weather conditions and migration. Subjective observation, however, indicated that overcast and high winds both apparently inhibited migration.

SUMMARY

Comparisons of autumnal shorebird migration with weather showed that in the first half of migration movements out of the study area were correlated only with wind shifts toward north and cold front passage, correlation with wind being higher. During the last half of migration, however, there was significant correlation with wind, cold fronts, falling daily minimum temperature, and precipitation, the influence of the last two factors increasing considerably. Precipitation was considered to have only an indirect effect by reducing feeding area and food availability.

It was concluded that a clockwise wind shift toward north was the primary stimulus to autumnal migratory movement of shorebirds in this area, the other weather factors being of indirect or secondary importance, and having a masking effect on this relation.

ACKNOWLEDGMENTS

I am much indebted to Dr. S. Charles Kendeigh for his guidance throughout this study. To Dr. Richard R. Graber and Miss Sylvia Sue Hassler (since deceased) of the Illinois Natural History Survey, gratitude is expressed for making certain weather data available and for valuable discussions and suggestions. Thanks are due also Dr. John L. Zimmerman, Dr. John E. Williams, and John Bursewicz for their help in making observations.

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CARCASS ANALYSIS OF WILD AND THERMAL-STRESSED DICKCISSELS[1]

JOHN L. ZIMMERMAN

STUDIES of weight fluctuations in birds have indicated that seasonally related changes in mass occur regularly in the adults (Baldwin and Kendeigh, 1938; Nice, 1938). The abrupt vernal and autumnal accumulation of fat in migrants has been well documented (Helms and Drury, 1960; King and Farner, 1959; Norris et al., 1957; Odum and Connell, 1956; Odum and Perkinson, 1951; Ward, 1963), and the causative factors involved have been experimentally investigated (Kendeigh, West, and Cox, 1960; King, 1961; Koch and De Bont, 1951; Lofts and Marshall, 1960; Odum and Major, 1956; Schildmacher and Steubing, 1952). Few data, however, are available on lipid levels at other times of the year or on the amounts of water and protein at any season.

The Dickcissel (*Spiza americana*) nests in North America during the summer months, arriving in the southern part of its breeding range along the coast of Texas in April and reaching its northern nesting limit on the Great Plains in June. From late August to October the Dickcissel migrates to its tropical wintering area, which extends from 19° N in Mexico to 5° N in northern South America.

This paper is a report of the amounts of the major body constituents of wild Dickcissels throughout most of the year, and the effect of thermal stress at both extremes of its tolerable temperature range on these levels.

METHODS

Most birds were captured with Japanese mist nets, but some additional individuals were shot. Summer birds were obtained during 1961 and 1962 in Piatt and Champaign Counties, Illinois, and winter birds were collected from flocks near Tocumen and Pacora, Republic of Panama, in January and February 1961. Spring migrants were secured from flocks passing through the Canal Zone Biological Area, Barro Colorado Island, Canal Zone, from late February to mid-May 1961. Diel variation was reduced, but certainly was not eliminated, in that all were captured in the forenoon.

Freshly caught birds were weighed to the nearest 0.1 gram immediately, to obtain the wet weight, and the visible fat class and molt condition noted. Fat was recorded as a modified McCabe index (McCabe, 1943) that allowed ordering at 14 levels which were later pooled into four classes (Table 1). Molt

[1] Based on part of a doctoral thesis in the Department of Zoology, University of Illinois, Urbana, Illinois.

Table 1

Visible Fat Class Description

Assigned quantitative value	Description
1	From a lean condition with no fat in the furcular depression (interclavicular fossa) to the condition in which the furcular area is well lined with fat and the first definite accumulation of abdominal fat is apparent
2	Fat beginning to fill the furcular depression, and a sheet of fat almost covering the abdomen
3	Furcular depression full of fat, and abdomen completely covered with a layer of fat
4	Furcular area and abdomen bulging with fat

was determined as light (less than 10 body feathers growing in), medium (10–25 body feathers and/or 2–4 flight feathers growing in), or heavy (more than 25 body feathers and/or 2–4 flight feathers growing in). Captives were provided with food and water ad lib.

Data on thermal-stressed birds were obtained upon their death at high and low temperatures in thermostatically controlled temperature cabinets. After the completion of the postnuptial molt, Dickcissels were exposed to increasingly higher temperatures at 12 hours photoperiod, that of their tropical wintering grounds, and to increasingly colder temperatures at 10 hours photoperiod, that of the coldest month at temperate latitudes. Additional postnuptial captives were subjected to the cold stress of the Illinois winter under outdoor conditions. Summer birds were placed under thermal stress at both high and low temperatures at 15 hours photoperiod, that of the longest day at the latitude of central Illinois. Since with all cabinet birds the temperature was not changed until the birds maintained a constant weight in order that their existence energy requirements could be measured (Zimmerman, 1963), there probably was temperature acclimation prior to finally reaching the lethal limits.

Captives were also held outdoors in the Canal Zone during the winter and spring and were sacrificed for carcass analysis at the peak of vernal fat deposition. The wet weight of both these and the thermal-stressed captives was determined at death.

Most carcasses were frozen until ready for analysis, but birds returned from the Canal Zone and some Illinois specimens were preserved in 95% ethanol. Dry weights, which include the feathers, were obtained after placing the cut-up bird in a vacuum oven at 60–70 C until a constant weight was reached. The

TABLE 2

BODY CONSTITUENTS OF WILD BIRDS—IN GRAMS*

Date	No.	Wet weight	Water	Lipids	Protein	Carbohydrates and ash
Wintering ♂ ♂						
25 Jan.	2	30.4 ± 0.80	18.070 ± 0.73 (59.4)	4.889 ± 0.47 (16.1)	6.334 ± 0.11 (20.8)	1.108 ± 0.43 (3.6)
15 Feb.	3	29.4 ± 2.44	19.445 ± 2.22 (65.8)	1.749 ± 0.35 (5.8)	6.389 ± 0.07 (22.0)	1.817 ± 0.19 (6.4)
Wintering ♀ ♀						
25 Jan.	3	23.0 ± 0.91	14.999 ± 0.54 (65.3)	1.126 ± 0.29 (4.9)	5.532 ± 0.02 (24.2)	1.310 ± 0.25 (5.7)
15 Feb.	2	25.9 ± 0.45	15.599 ± 0.75 (60.4)	3.287 ± 1.21 (12.6)	5.607 ± 0.01 (21.7)	1.358 ± 0.02 (5.3)
Migrating ♂ ♂						
28 Feb.	2	26.0 ± 0.10	15.691 ± 0.93 (60.4)	3.036 ± 0.82 (11.7)	6.133 ± 0.11 (23.6)	1.140 ± 0.32 (4.4)
8 Mar.	3	28.2 ± 1.48	17.415 ± 0.18 (62.1)	2.920 ± 1.25 (10.0)	6.352 ± 0.09 (22.6)	1.513 ± 0.11 (5.4)
22 Mar.	8	27.7 ± 0.39	17.178 ± 0.27 (62.0)	2.617 ± 0.21 (9.4)	6.354 ± 0.11 (22.9)	1.576 ± 0.04 (5.7)
2 Apr.	7	29.0 ± 0.79	16.800 ± 0.29 (58.5)	4.198 ± 0.67 (14.2)	6.135 ± 0.06 (21.2)	1.767 ± 0.08 (6.1)
13 Apr.	3	26.6 ± 1.13	15.679 ± 0.75 (58.9)	3.540 ± 0.26 (13.3)	5.869 ± 0.18 (22.1)	1.545 ± 0.04 (5.8)
Migrating ♀ ♀						
28 Feb.	2	23.3 ± 2.45	13.500 ± 1.01 (58.3)	3.245 ± 1.13 (13.6)	5.223 ± 0.22 (22.6)	1.282 ± 0.09 (5.5)
22 Mar.	1	23.8	15.591 (65.5)	1.272 (5.3)	5.625 (23.6)	1.313 (5.5)
2 Apr.	1	27.2	14.507 (53.3)	6.176 (22.7)	5.200 (19.1)	1.317 (4.8)
13 Apr.	3	24.3 ± 1.41	14.643 ± 0.77 (60.4)	2.882 ± 0.54 (11.8)	5.316 ± 0.22 (22.0)	1.427 ± 0.10 (5.9)
Breeding ♂ ♂						
13 June	3	29.3 ± 0.18	19.660 ± 0.28 (67.2)	9.995 ± 0.47 (3.4)	7.142 ± 0.08 (24.4)	1.470 ± 0.08 (5.0)
10 July	4	28.1 ± 0.20	18.766 ± 0.20 (66.8)	0.953 ± 0.07 (3.4)	6.757 ± 0.11 (24.1)	1.599 ± 0.08 (5.7)
19 July	4	27.9 ± 0.72	18.759 ± 0.54 (67.2)	0.841 ± 0.07 (3.0)	6.885 ± 0.20 (24.7)	1.440 ± 0.05 (5.2)
27 July	5	28.4 ± 0.61	19.441 ± 0.47 (68.3)	1.030 ± 0.06 (3.6)	6.393 ± 0.13 (22.5)	1.576 ± 0.05 (5.6)
8 Aug.	6	29.0 ± 0.30	19.682 ± 0.20 (67.9)	1.144 ± 0.10 (4.0)	6.639 ± 0.18 (22.9)	1.531 ± 0.07 (5.3)

* Figures in parentheses are the per cent of wet weight.

TABLE 2 (*Continued*)

Date	No.	Wet weight	Water	Lipids	Protein	Carbohydrates and ash
Breeding ♀ ♀						
13 June	3	25.4 ± 1.20	17.175 ± 0.87 (67.7)	1.116 ± 0.16 (4.4)	5.835 ± 0.08 (23.1)	1.241 ± 0.08 (4.9)
10 July	1	24.6	10.903 (68.7)	0.790 (3.2)	5.536 (22.5)	1.371 (5.6)
19 July	1	25.1	16.723 (66.6)	1.324 (5.3)	5.524 (22.0)	1.529 (6.1)
27 July	3	24.9 ± 0.53	16.499 ± 0.29 (66.3)	1.179 ± 0.12 (4.8)	5.588 ± 0.05 (22.6)	1.806 ± 0.58 (7.2)
8 Aug.	1	25.9	17.930 (69.2)	0.757 (2.9)	5.971 (23.1)	1.242 (4.8)

amount of water in the carcass was determined by subtracting the dry weight from the wet weight of the bird at death. Fat determinations are on the basis of ether extractable lipids obtained with a Soxhlet apparatus (see Odum, 1960). There was no difference in the amounts of extractable lipids between frozen birds and those previously treated with alcohol. (Compare lipid amounts of frozen June and early July wild birds with alcohol-preserved wild birds from late July and August, Table 2.) Protein values are based on total organic nitrogen determined by the Kjeldahl method (see Fischer, 1961:229–231).

Procedures for the statistical treatment of data were taken from Dixon and Massey (1957) and Jacob and Seif (mimeo). A probability level of 0.05 was required for significance. The indicated variation associated with the means is the standard error.

CARCASS ANALYSIS OF WILD BIRDS

The body composition of 71 Dickcissels (50 males and 21 females) from both the summer and winter ranges is presented in Table 2 and Figs. 1 and 2.

The greater wet weight of males is significantly different from that of females. This is due to a significant difference in the amounts of protein and water between the sexes. There is no sex difference in the weights of the remainder of carbohydrates and ash or in the weights of the lipids.

The wet weight of neither males nor females showed any significant changes throughout the period of collection. There are positive correlations between wet weight and lipids, water, and protein which are significant in all cases except between wet weight and lipids in females. The weight increase obtained in captives during the vernal migratory period in the Canal Zone was

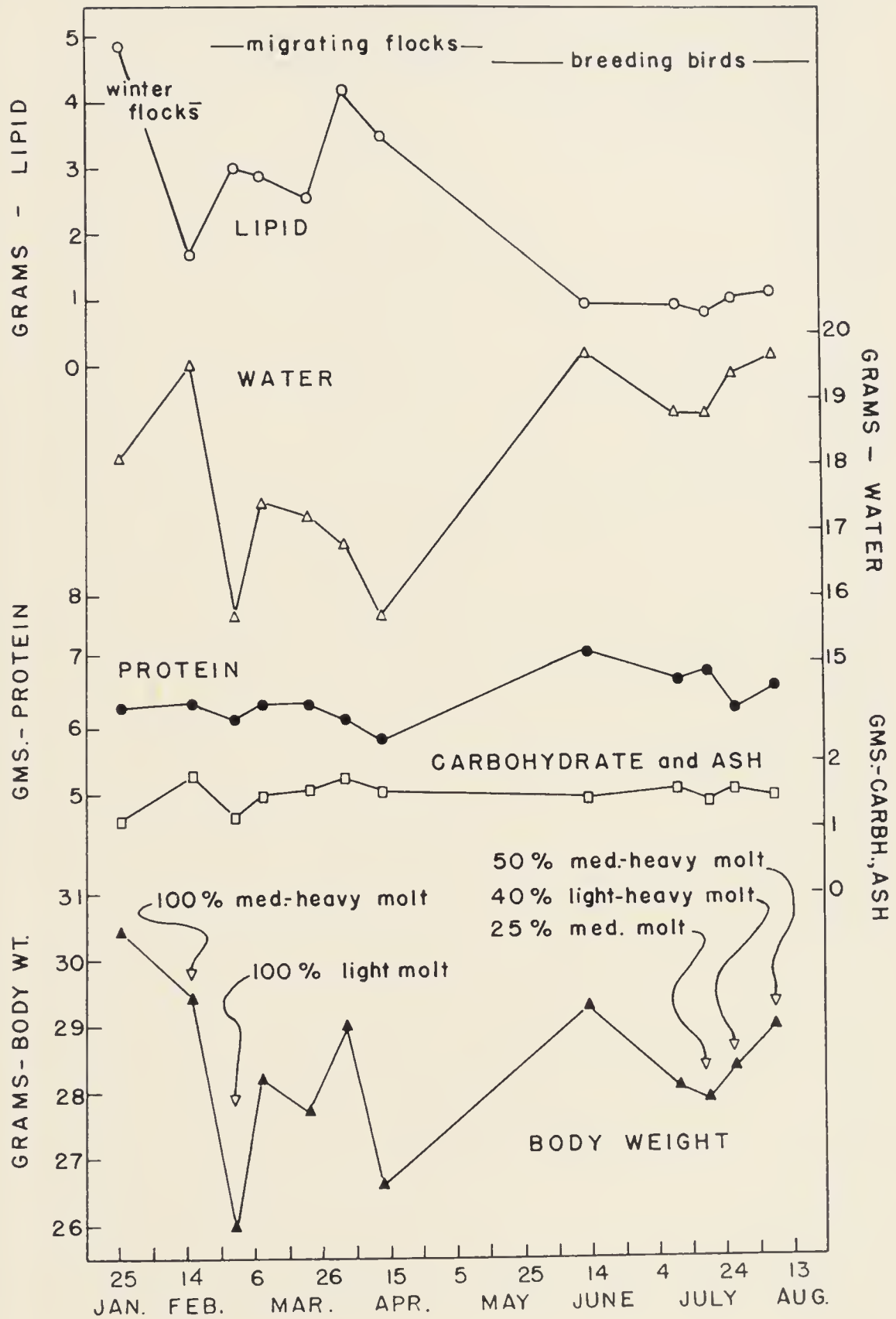

FIG. 1. Carcass components of wild males from January to August. See text for explanation of molt.

Table 3

Carcass Analysis of High Depot Fat, Spring Dickcissels—in Grams*

	Males	Females
Number	7	5
Wet weight	38.4 ± 0.94	32.7 ± 1.01
Water	19.186 ± 0.41 (50.0)	15.577 ± 0.45 (47.7)
Lipids	10.876 ± 0.79 (28.1)	10.464 ± 0.80 (31.9)
Protein	6.120 ± 0.08 (16.4)	5.000 ± 0.07 (15.3)
Carbohydrates and ash	2.399 ± 0.28 (6.5)	1.699 ± 0.07 (5.2)

* Figures in parentheses are the per cent of wet weight.

not demonstrable in wild-caught birds during the same period. These migrants were netted in the morning following a night of presumed movement, which could have depleted their fat stores, reducing their weight. Helms (1959) has illustrated such an effect in other fringillids. The wet weight in both sexes was most constant during the summer months.

The wintering lipid level of nonmolting birds was high, while the prenuptial molt was correlated with a significant drop in fat. A similar decrease in body lipids associated with this molt has been reported in the White-throated Sparrow (*Zonotrichia albicollis*) (Odum and Perkinson, 1951) and the White-crowned Sparrow (*Z. leucophrys gambelii*) (King and Farner, 1959).

During the spring migration the lipid level remained about that of wintering birds except for the high early April value, which in females is significantly different from those at any other time sampled and in males is significantly different from all others except nonmolting winter birds and other migrants. Lipid values of captives killed at maximum spring fat deposition (Table 3) were 2.6 and 1.7 times greater than the early April values in wild males and females, respectively. The effect of early morning capture on fat content has been mentioned above. The lack of significant fat increase during the early migratory period in the Canal Zone, as well as the lower level of the April amounts when compared to obese captives killed a month later, may also be attributed to the possibility that maximum deposition does not occur until later in their migratory journey. A wintering population of the Slate-colored Junco (*Junco hyemalis*) studied by Johnston (1962) departed without fat reserves, while captives from this population did subsequently undergo

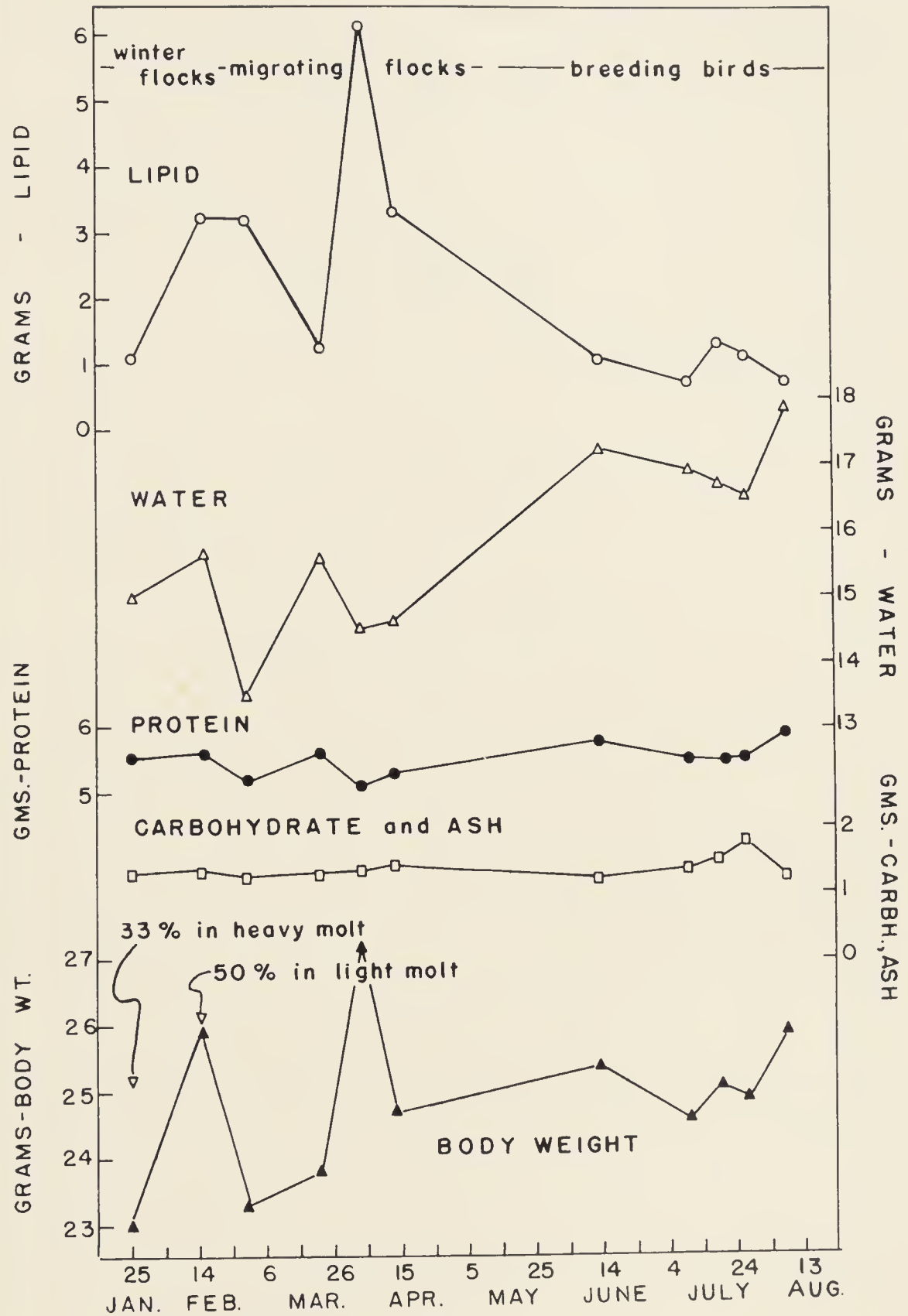

FIG. 2. Carcass components of wild females from January to August. See text for explanation of molt.

vernal fat deposition. Recent data presented by Caldwell, Odum, and Marshall (1963) illustrate a similar situation occurring in wild birds during fall migration.

Although carcass data were not available, the visible fat of birds captured upon arrival in Illinois during late April and early May indicated a lack of appreciable fat stores (Zimmerman, 1963). The lipid content of birds on the breeding grounds remained constant and low, and, being already minimal, was not reduced by the occurrence of the postnuptial molt. No wild birds were obtained during autumnal fat deposition.

The amount of protein remained relatively stable. In females there are no significant differences throughout the period of collection. In males summer values were high; the amounts for 13 June, 19 July, and 10 July are significantly different from any during either winter or spring but similar, for the most part, to the 27 July and 8 August values. The higher protein level in breeding males probably reflects the anabolic action of androgens in protein metabolism (Turner, 1960:343–345), an effect suggested for the high carcass protein in the Canada Goose (*Branta canadensis*) during the summer (Hanson, 1962; Williams, 1964).

There are no significant differences from January to August in the water content of females, but values were highest in breeding birds and lowest in migrants. Males had similar trends, although generally winter and summer birds were similar. Like the females, the amount of water was lowest during migration. The values for 28 February, 2 April, and 13 April are significantly different from all others except the other migrant samples and that of 25 January. Since these migrating birds were obtained in the morning, these low values reflect the dehydrating effect of a night of active migration, an average decrease of as much as 4% of the wet weight when compared to wintering birds. This contention is supported in that the obese May-killed captives (Table 3) had water amounts similar to leaner, nonmigrating wild birds (Table 2).

The remainder, mostly ash and some carbohydrate, was constant from January to August. There are no significant changes in the females. There are significant differences between some values at the extremes of the range in males, but no relationship exists with the time of year.

FAT CLASS AND BODY CONSTITUENTS OF WILD BIRDS

With data grouped according to visible fat class (Fig. 3), there is no significant correlation in either sex between wet weight and water or between wet weight and the fat-free dry weight. While the coefficients of correlation between wet weight and the weight of the lipids are also not significantly different from zero with just four fat classes (males: $r = 0.859$, females: $r =$

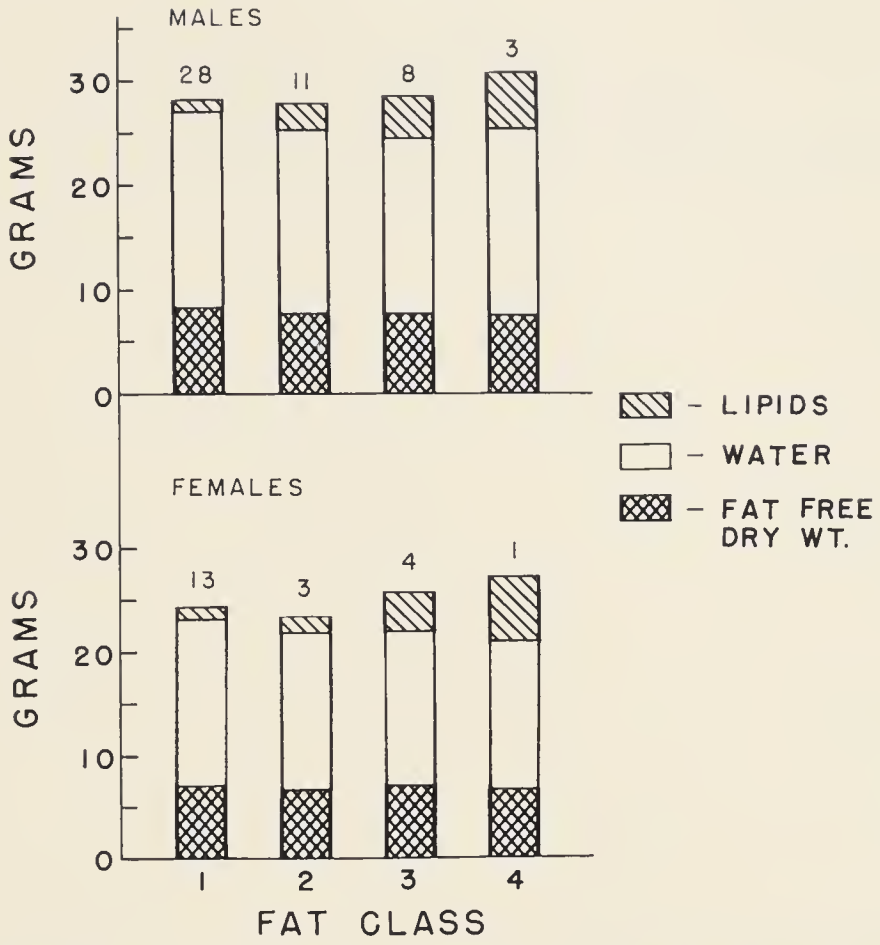

FIG. 3. Lipids, water, and fat-free dry weight of wild males and females according to visual fat classes. The number at the top of each histogram is the sample size for that fat class.

0.948), the magnitude of these coefficients does suggest a strong positive relationship between the average wet weight and the amount of lipids in these fat classes.

Birds were initially placed in one of 14 visible fat categories, but upon analysis of their lipid content it was realized that these original fat classes were not truly indicative of the fat reserves available to the birds. This was particularly evident in the first 8 of these 14 classes in which lipid quantity, while generally increasing with each category, still did not increase by a statistically significant amount between class 1 and class 7. Since there is no difference between the sexes in the weights of their lipids, data from both sexes were pooled for each of the four fat classes described in Table 1, and the lipid quantities of these fat classes are significantly different from each other.

TERMINAL CARCASS ANALYSIS AFTER THERMAL STRESS

For all Dickcissels under constant photoperiod conditions, over one-half of the birds could sustain an existence level energy balance as indicated by

TABLE 4

TERMINAL BODY CONSTITUENTS—IN GRAMS*

	Under Heat Stress	
	12 hr (postnuptial)	15 hr (summer)
♂ ♂		
Wet weight	21.4 ± 4.40	18.8 ± 0.79
Water	10.619 ± 0.87	11.332 ± 0.49
	(50.9)	(60.2)
Lipids	3.774 ± 3.10	0.815 ± 0.26
	(15.3)	(4.0)
Protein	5.235 ± 0.17	5.419 ± 0.12
	(25.4)	(28.9)
Carbohydrates and ash	1.772 ± 0.26	1.273 ± 0.01
	(8.4)	(6.8)
Number	2	8
♀ ♀		
Wet weight	16.2 ± 0.49	
Water	9.259 ± 0.36	
	(57.3)	
Lipids	1.129 ± 0.51	
	(6.8)	
Protein	4.637 ± 0.27	
	(28.6)	
Carbohydrates and ash	1.175 ± 0.06	
	(7.2)	
Number	3	

* Figures in parentheses are the per cent of wet weight.

their maintenance of a constant weight over a 3-day period at any given temperature up to (heat stress) or down to (cold stress) the lethal temperature. The lethal temperature, then, is the temperaure at which at least 50% of the birds under the respective conditions were in constant negative energy balance leading eventually to death within 24 hours for most but only after several days for a few.

The upper lethal limit of temperature tolerance in birds after the fall molt at 12 hours photoperiod and in summer birds at 15 hours was 44 C. The lower lethal limit for birds after the completion of the postnuptial molt at 10 hours photoperiod was –1 C, and for summer birds at 15 hours was –2 C. Birds exposed to the outdoor conditions of the Illinois winter experienced 50% mortality at a mean daily temperature of –3 C. The carcass analyses of these birds are compiled in Table 4, and the statistical relationships are presented in Table 5. The differences between body components were related not to

TABLE 4 (*Continued*)

	Under Cold Stress		
	15 hr (summer)	10 hr (postnuptial)	Outdoors (postnuptial)
♂ ♂			
Wet weight	22.4 ± 0.20	22.8 ± 0.65	24.2 ± 0.28
Water	14.819 ± 0.23 (66.0)	14.883 ± 0.53 (65.3)	16.008 ± 0.24 (66.2)
Lipids	0.371 ± 0.02 (1.7)	0.293 ± 0.02 (1.3)	0.367 ± 0.05 (1.5)
Protein	5.631 ± 0.10 (25.1)	5.949 ± 0.19 (26.2)	6.069 ± 0.06 (25.1)
Carbohydrates and ash	1.617 ± 0.04 (7.2)	1.659 ± 0.10 (7.3)	1.739 ± 0.03 (7.2)
Number	8	6	11
♀ ♀			
Wet weight		19.4 ± 0.17	20.8 ± 0.48
Water		12.922 ± 0.15 (66.7)	13.834 ± 0.42 (66.4)
Lipids		0.228 ± 0.02 (1.2)	0.310 ± 0.05 (1.5)
Protein		4.853 ± 0.10 (25.1)	5.129 ± 0.10 (24.7)
Carbohydrates and ash		1.372 ± 0.08 (7.1)	1.547 ± 0.07 (7.5)
Number		4	5

photoperiod, sex. or season, but as might be expected, to the nature of the thermal stress.

The terminal wet weight of heat-stressed birds was lower due to a marked dehydration as well as generally lower protein and carbohydrate and ash levels. Lipids were highest in this group. Death at the upper limit of temperature tolerance probably develops from a variety of effects ramifying from the disruption of homeostasis by increasing hyperthermia. Heat death is not due to the exhaustion of energy stores depleted by a high metabolic rate. since terminal fat reserves were high. The reduction in the free water content of these birds, resulting from the utilization of most available water for evaporative heat loss from the respiratory tract, may be the proximal factor responsible for death. The increased water requirement at high temperatures has been illustrated in birds by several authors (Bartholomew and Cade, 1956; Bartholomew and Dawson, 1954; Kendeigh, 1944), and the im-

TABLE 5

RANK AND DIFFERENCES OF THE VARIOUS CARCASS CONSTITUENTS ACCORDING TO ENVIRONMENTAL CONDITION*

		Heat stress		Cold stress		
		12 hr	15 hr	15 hr	10 hr	Outdoors
Wet weight	♂ ♂	$2^{1,2}$	1^{1}	3^{2}	4^{2}	5^{2}
	♀ ♀	1^{1}			2^{2}	3^{3}
Lipids	♂ ♂	5^{2}	4^{1}	3^{1}	1^{1}	2^{1}
	♀ ♀	3^{2}			1^{1}	2^{1}
Water	♂ ♂	1^{1}	2^{1}	3^{2}	4^{2}	5^{2}
	♀ ♀	1^{1}			2^{2}	3^{2}
Protein	♂ ♂	1^{1}	2^{1}	$3^{1,2}$	$4^{2,3}$	5^{3}
	♀ ♀	1^{1}			2^{1}	3^{1}
Carbohydrate and ash	♂ ♂	5^{2}	1^{1}	2^{2}	3^{2}	4^{2}
	♀ ♀	1^{1}			$2^{1,2}$	3^{2}
Season		Winter	Summer	Summer	Winter	Winter

* The rank of the means for each comparison (across) are numbered from lowest to highest. Means (see Table 4) which are *not* significantly different have the same superscript associated with their rank numbers.

portance of water in thermoregulation (Dawson, 1954) and its limits as a means of heat dissipation (Dawson, 1958; Kendeigh, op. cit.) have been described.

In cold-stressed birds the terminal wet weight was greater than that of birds dying at high ambient temperatures, even though lipid levels were almost nil, due to the greater amounts of the other fractions. Among these cold-stressed birds, those under outdoor conditions had the highest, although not always significantly so, levels of all components except the negligible lipids. Most of these birds died at lower environmental temperatures than those at cold, constant temperatures. Both these differences in the outdoor individuals are probably related to the fluctuating temperature which allows short, daily reprieves from near lethal conditions, and death results from the effects of the relatively short, but intense, nightly low. Birds at constant temperatures, on the other hand, suffer continuing attrition under unvarying cold stress and die "earlier" but more exhausted.

The weights of body constituents in wild summer birds were compared with summer birds under heat and cold stress at 15 hours, and the weights of components in wild winter birds were compared with postnuptial birds under heat stress at 12 hours and cold stress at 10 hours and outdoors. Thermal stress, no matter at which extreme, reduced the weights of protein and water when compared to wild birds at the same season. The weights of lipids are similar in heat-stressed captives and wild birds in both summer and winter.

TABLE 6

ESTIMATED CARBOHYDRATE LEVELS*

		Wild	Cold stress			Heat stress		High depot fat captives
			15 hr	10 hr	Outdoors	15 hr	12 hr	
Remainder, % dry wt	♂ ♂	15.4	21.4	21.1	21.3	17.0	17.5	13.0
	♀ ♀	15.6		21.2	22.2		17.2	9.9†
Carbohydrates, % dry wt	♂ ♂	3.4	9.4	9.1	9.3	5.0	5.5	1.0
	♀ ♀	3.6		9.2	10.2		5.2	0.0
Estimated dry wt of carbohydrates	♂ ♂	0.342	0.716	0.719	0.760	0.375	0.593	0.193
	♀ ♀	0.321		0.594	0.713		0.361	0.0
Number	♂ ♂	50	8	6	11	8	2	5
	♀ ♀	21		4	5		3	5

* Based on Turček's (1960) estimate of ash as 12% of dry weight with $s = 1.5\%$.
† This value is within $2s$ of Turček's average and assumed to include no carbohydrate portion.

but the cold-stressed individuals are lower than all three. The weight loss of mice exposed to lethal cold temperatures was similarly due mostly to utilization of fat reserves plus some reduction in protein and water (Hart and Heroux, 1956). In most cases the weights of the remainder of ash and carbohydrate are similar in wild and thermal stressed birds.

ESTIMATION OF CARBOHYDRATE AMOUNTS

After the removal of water, the extraction of lipids, and the determination of protein, there is a remainder composed of ash and carbohydrates. Turček (1960) gives the ash value of the passerines analyzed as 12% of the dry weight. Using this value, an estimation of the amounts of carbohydrates was made (Table 6). These approximations are consistent with the conditions at death, using the quantity in wild birds as a point of reference. Even at death, cold stress values are high, indicating a high level of gluconeogenesis in connection with thermoregulation, as previously evidenced in the reduced lipid levels, while the content in heat-stressed birds is lower and more like that of the wild population. Birds at temperatures above thermal neutrality are not concerned with calorigenesis. The very low levels in birds during the peak of fat deposition are corroborated by the findings of Farner et al. (1961) which show a reduction in the glycogen content of liver and pectoral muscle at this time.

SUMMARY

The greater weight of males is significantly different from that of the females due to the higher levels of protein and water. Amounts of lipids and the carbohydrate-ash remainder show no sex differences.

A spring migratory weight peak could not be illustrated in wild birds; and although the fat content of migratory birds in early April was high, it was much lower than the quantity extracted from obese premigratory captives. Early morning capture and the later occurrence of maximum fat deposition are suggested as factors responsible for these lower lipid levels. Dehydration by a night of migration is apparent in the free water content of migrants.

Winter lipid levels in wild birds were reduced by the prenuptial molt. Amounts of lipids in both sexes on the breeding grounds were constant and, being already minimal, were not affected by the postnuptial molt.

Significantly higher amounts of proteins were found in males during the breeding season.

There is a significant difference in the amount of lipids between each of the four visible fat classes that were used in this study.

Birds dying under cold stress had negligible lipids, while carcasses of heat-stressed birds were high in lipids, but low in water. Under both extremes of thermal stress, the weights of protein and water were less than that of wild birds at the same season.

Estimates of the amounts of carbohydrates revealed similar levels in heat-stressed birds and wild birds, high levels in birds dying under cold stress, and very low amounts in birds at the peak of vernal fat deposition.

ACKNOWLEDGMENTS

Great appreciation is due Dr. S. C. Kendeigh, who directed the study. I would also like to thank J. B. Olson and J. E. Williams for aid in collecting specimens, and S. A. Olson and J. Zar for the biochemical analyses. Thanks are also due to Dr. M. Moynihan and his staff at the Canal Zone Biological Area for making it possible to complete the tropical phase of this research. This project was financed by grant G 14261 from the National Science Foundation.

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MOUTH COLOR OF NESTLING PASSERINES AND ITS USE IN TAXONOMY

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Mouth color has received little attention as a taxonomic character although tongue and palatal markings of nestlings have proved useful in determining relationships in the estrildines (Delacour, 1943; Steiner, 1960). I use the term mouth color in the restricted sense and exclude the flanges, mandibles, tongue, or associated structures which may also be brightly colored or patterned in nestlings. Recently Skutch (1954, 1960) has shown that mouth colors of nestling passerines are conservative, often delimiting families. However, his descriptions of the mouth color of the young of certain Central American parulids (Skutch, 1954) differed from my observations on North American species. This led me to review the distribution of mouth colors in nestling passerines, to assess their function and the probable selective pressures affecting them, and finally to evaluate their use in taxonomy. Since relatively little published information on mouth colors is available, I hope that this brief survey will stimulate the acquisition of additional information.

There are several problems encountered in comparing descriptions of mouth color by different workers. First, the exact age of the birds at the time of examination is not always stated, although this may be important because of changes which take place. For example, the mouths of newly hatched Tree Pipits (*Anthus trivialis*) are deep orange, turning crimson at 4 days (Ticehurst, 1910). In many species the color of the nestling differs from that of the adult. A second problem is the lack of standardization of color terminology, and where specimens were used, this is further complicated because of the rapid fading which takes place after death. Despite these variables, the mouth colors of almost all nestling passerines are either red or yellow, although in one group (corvids) they are described as "mauve" or "reddish purple" and in others (Witherby et al., 1938) as being "pinkish-orange" or "orange-yellow."

Wetherbee (1961) studied the mouth colors of many North American neonatal birds hatched in incubators and suggested that mouth coloration is due to at least three different factors: (1): "a horny yellow covering sheathing the bones of the bill" giving yellow color to young wrens, titmice, starlings, swallows, flycatchers, and thrushes; (2) "a transitory red or orange coloring of the epidermis by pigments from the yolk, probably carotinoids." For example, the Red-winged Blackbird (*Agelaius phoeniceus*) and Rose-breasted Grosbeak (*Pheucticus ludovicianus*) feed on phytophagous insects rich in carotenoids and since xanthophyll is selectively deposited in the egg, the food of the

parents probably determines the color of the nestlings' mouths; (3) differences in the extent of capillary vascularization. According to Wetherbee, this is responsible for the red coloration of the mouths of sparrows. There is certainly a need for further investigation of the biochemical and physiological factors underlying mouth color in young birds. Wetherbee's conclusion concerning the effect of diet on pigments of the young is questionable because many insectivorous species have young with red linings, others with yellow (Table 1).

The bright mouth linings of the young serve to direct and stimulate feeding by the adult, and conspicuousness is thus to be expected (Armstrong, 1947). The type of nest may be correlated with mouth lining color in some cases, since elaborate and conspicuous markings and globular projections are found in and around the mouths of young of certain species which nest in cavities or have covered nests (Ticehurst, 1910; Swynnerton, 1916). Another interesting adaptation occurs in parasitic cuckoos. The mouth-lining colors of cuckoos which eject nestmates do not resemble the hosts' mouth colors but in cases where the cuckoo young do not eject the young they are similar. Moreover, the mouth lining of the young cuckoo is yellow for the first few days, resembling the colors of the most common host species and then gradually changes to red in 9 days (Armstrong, 1947). Another brood parasite, the Brown-headed Cowbird (*Molothrus ater*), resembles nonparasitic icterids in having a red mouth lining. However, 15 of the 50 most commonly parasitized species (Friedmann, 1963) have yellow mouth linings, and there is no evidence that fewer young cowbirds are raised successfully by these hosts. The higher incidence of parasitism of species with red mouth linings probably reflects their numerical preponderance in North America.

Although most passerine mouth linings are various shades of red or yellow, the linings of adults include, in addition, black, white, and bright green (Armstrong, 1947). Particularly distinctive colors are often associated with opening of the mouth during displays, especially those involved in courtship, such as courtship feeding, and to a lesser degree, threat. For example, those birds of paradise which open their bills during their elaborate courtship displays have mouth linings of various shades of green or more rarely yellow or white (Armstrong, 1947). In some cases there is obviously selection for maximum contrast with the plumage, e.g., a white gullet in the Magnificent Riflebird (*Craspedophora magnifica*) and black in the Gannet (*Morus bassanus*) (Armstrong, 1947). In a few species there is sexual dimorphism, the color of the male usually being more striking (Armstrong, 1947). The greater divergence of mouth-lining color in adults of closely related species than in young is probably related to their frequent incorporation into displays involved in reproductive isolation. In the case of the young, there is evidently little if

TABLE 1
MOUTH-LINING COLORS OF NESTLING PASSERINES

Y yellow or orange-yellow
R red or pink

Tyrannidae	Y	Skutch, 1960; Wetherbee, 1961
Alaudidae	Y	Witherby et al., 1938
Hirundinidae	Y	Witherby et al., 1938; Wetherbee, 1961
Oriolidae	R	Witherby et al., 1938
Corvidae	R	Witherby et al., 1938; Skutch, 1960
Paridae	Y	Witherby et al., 1938; Wetherbee, 1961
Certhiidae	Y	Witherby, et al., 1938
Pycnonotidae	R	Swynnerton, 1916
Cinclidae	Y	Witherby et al., 1938
Troglodytidae	Y	Witherby et al., 1938; Skutch, 1960
Mimidae	Y	Engels, 1940; pers. obs.
Turdidae	Y	Witherby et al., 1938; Skutch, 1960; Wetherbee, 1961
Sylviidae	Y, R	Witherby et al., 1938; Swynnerton, 1916
Muscicapidae	Y	Witherby et al., 1938
Prunellidae	R	Gilliard, 1958
Motacillidae	Y, R	Witherby et al., 1938
Bombycillidae	R	Wetherbee, 1961
Laniidae	Y	Swynnerton, 1916; Witherby et al., 1938
Sturnidae	Y	Witherby et al., 1938; Wetherbee, 1961
Vireonidae	Y	Skutch, 1960
Coerebidae	R	Skutch, 1954; Skutch, 1962
Parulidae	R, Y	Skutch, 1954; pers. obs.
Ploceidae	R, Y	Swynnerton, 1916
Icteridae	R	Skutch, 1954
Thraupidae	R	Skutch, 1954
Fringillidae	R	Witherby et al., 1938; Skutch, 1954; Wetherbee, 1961

any selective pressure for species specificity, as would be expected if its function is primarily stimulation and orientation of the adult's feeding response. In this case any conspicuous coloration would be about equally effective.

It is apparent from the data (Table 1) that nestling mouth-lining color is usually a good family character. There are a few exceptions. Several cardueline species (but so far as is known, no other higher passerines) have two colors, e.g., red and blue in Hawfinches (*Coccothraustes coccothraustes*) and pink and yellow in Crossbills (*Loxia curvirostra*) (Witherby et al., 1938). Groups having intrafamilial variation are Sylviidae, Ploceidae, Motacillidae, and Parulidae. In the first three groups some members have open nests, others covered, and there are special adaptations such as tongue spots in some sylviids and motacillids, and even more elaborate structures in certain ploceids, indicating selection for conspicuousness.

There are no apparent adaptive reasons for the presence of red mouth linings in some parulids and yellow in others. Central American representatives of other groups (e.g., emberizines) do not differ in mouth-lining color from North American species, although the type of nest is different (domed nests being more common in tropical forms). All North American parulids examined (17 species of 8 genera) had red linings. However, certain primarily Central American species have yellow linings: Buff-rumped Warbler (*Basileuterus fulvicauda*), Black-cheeked Warbler (*B. melanogenys*), Slate-throated Redstart (*Myioborus miniatus*), and Collared Redstart (*M. torquatus*) (Skutch, pers. comm.). Mr. Eliot Porter (pers. comm.) reports that his Kodachromes of nestling Red-faced Warblers (*Cardellina rubrifrons*) and Painted Redstarts (*Setophaga picta*) show deep orange-yellow mouths which were definitely not red. Central American species with red linings include the Flame-throated Warbler (*Vermivora gutturalis*) (Skutch, pers. comm.), and judging from published Kodachromes, the Olive Warbler (*Peucedramus taeniatus*) and Pink-headed Warbler (*Ergaticus versicolor*) as well. These warblers are the only nine-primaried oscines for which information is available which have yellow mouth linings. This probably indicates that *Myioborus, Basileuterus, Cardellina rubrifrons*, and *Setophaga picta* are a closely related assemblage. They are probably not very closely related to the wood warblers and their morphological resemblances may be the result of adaptations to similar feeding habits. Parkes (1961) has suggested that *Setophaga picta* is more closely related to *Myioborus* than to the supposedly congeneric American Redstart (*Setophaga ruticilla*). This is supported by the data on nestling mouth-lining colors.

Skutch (1962) questions the validity of placing the Bananaquit (*Coereba flaveola*), which has a red mouth lining, with the wood warblers since his observations showed Central American warblers have yellow linings. Since other warblers have red linings, there is no reason to doubt the relationship of *Coereba* to the parulids on the basis of this character.

It certainly does not follow that all forms with the same mouth-lining color are closely related, especially since the number of nestling mouth-lining colors is so limited. Convergence is probable in the case of certain unrelated families (Table 1). However, yellow is probably the more primitive nestling mouth color in passerines, judging from its distribution in the various families. Mouth-lining color bears out certain proposed relationships among the various "families" of nine-primaried oscines and also the "Muscicapidae" of Mayr and Amadon (1951) (including Mimidae, Troglodytidae, Muscicapidae, Cinclidae, Turdidae, Sylviidae in Table 1).

ACKNOWLEDGMENTS

This study was supported by a grant from the National Science Foundation (GB 891). I wish to thank Dr. Alexander Skutch and Mr. Eliot Porter for generously supplying me with their observations. I am grateful to Miss Mary Heimerdinger, Dr. Robert W. Ficken, and Dr. Kenneth C. Parkes for criticisms of the manuscript.

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THE BIRD FLEAS OF EASTERN NORTH AMERICA

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"The collectors of warm-blooded vertebrates. . .." wrote Karl Jordan (1929), "who should and might be the chief source of increase in our knowledge of the species of ectoparasites, as a rule neglect to collect the Arthropods occurring on mammals and birds obtained, lack of time frequently combined with a narrowness of outlook preventing the collector from going beyond the amassing of skins."

Parasitologists have complained for generations that nonparasitologists have not taken the proper interest in parasites. On the other hand, the literature of parasitology is filled with erroneous host determinations because the parasitologist has not taken the proper interest in birds and mammals. If, indeed such complaints have any validity today, it frequently stems from a simple lack of information rather than willful neglect or "narrowness of outlook." Outside his own field of specialization, the biologist is likely to be ignorant of the special techniques of finding and collecting specimens: of getting to the person most likely to use them; and most important, of the status of research in this unfamiliar field and of the potential value of any collections he might make.

This paper, therefore, attempts to survey for ornithologists the current status of knowledge of bird fleas in eastern North America, in the hope of stimulating collection of bird fleas and thus filling the numerous gaps in knowledge which will be indicated herein.

The study of fleas in North America, and indeed throughout the world, had its origins in the last decade of the nineteenth century. Carl Baker in the United States, N. C. Rothschild in England, and Julius Wagner in Belgrade began to work with this group almost simultaneously, and within two decades had laid the foundations of all our modern knowledge. In the intervening years, the fleas of American mammals have been rather thoroughly collected, while bird fleas, for some unknown reason, have been relatively neglected. The resultant lack of information is exemplified in the recent report by Geary (1959) on the fleas of New York. For the five common species of bird fleas, a total of 40 records was listed. Even the common and widespread chicken flea, *Ceratophyllus gallinae*, was represented by only 16 records. In contrast, common fleas found on rabbits, deermice, gray squirrels, and short-tailed shrews were represented by 75 to 100 records each. Obviously, additional collections of bird fleas must be made in order even to sketch the distribution of the most common species.

Since 1959, we have been gathering specimens wherever possible, but it

has become obvious to us that this project requires the cooperation of many collectors, bird banders, and especially persons who maintain birdhouses. Specialists in the study of fleas are too few and too widely scattered to accomplish the necessary fieldwork, but every community across the nation has its birdhouses. We would like to present a challenge to the many people interested in birds to provide the collections on which advances in our knowledge of bird fleas must be based.

All species of bird fleas currently known from eastern North America are included in the following accounts. Mammal fleas which have been recorded occasionally from birds are not included.

SPECIES ACCOUNTS

Echidnophaga gallinacea (Westwood).—The sticktight flea, introduced to North America from the Old World, is characteristically southern in distribution, but there are records from as far north as Rhode Island. It occurs on a great number of birds and mammals, deriving its common name from the fact that it attaches itself more firmly and more permanently than most other fleas. In the Southeast, it has been incriminated as one of the carriers of endemic typhus.

Ceratophyllus borealis Rothschild.—Although it is common in England and Europe, this flea occurs on the North American list only because of a single record from Greenland. It has been found on a variety of birds and, according to Smit (1957), it is especially common in nests of the Wheatear. Students of northern birds should look for it in nests of the Wheatear on the continent, where there seems to be no good reason for it to be absent.

Ceratophyllus celsus celsus Jordan.—In New York, this is the characteristic flea of the Cliff Swallow. Holland (1949), however, considered it a specific parasite of the Bank Swallow. Evidently it infests different hosts in different parts of its coast-to-coast range. Many more records are needed from the easily collected nests of the recorded hosts in order to determine its host distribution in different areas.

Ceratophyllus diffinis Jordan.—This is a nonspecific flea, which has been taken primarily in the northeastern United States and adjacent parts of Canada. Its range is transcontinental, however, the type locality being in British Columbia. Hosts include such diverse species as Ruffed Grouse, House Wren, Brown Thrasher, Catbird, bluebird, Robin, Ovenbird, and Savannah Sparrow. Largest numbers have been secured from ground nests, where it should be further sought.

Ceratophyllus gallinae (Schrank).—Because of its affinity for domestic fowl, this is the most commonly collected of all our bird fleas. It is commonly found on House Sparrows, and there are records from a variety of other wild birds. A record of *C. niger* Fox, cited by Stewart (1928, 1933) as occurring in New York, is quite certainly an error and should be referred to this species (cf. Geary, 1959:45).

Ceratophyllus garei Rothschild.—This species is Holaretic in distribution and is found on a variety of hosts, largely ground-nesting species. It appears to be more common in western North America than in the East, but this may be due to lack of collecting in our area. It should be especially sought in nests of waterfowl and shore birds, although it is by no means confined to these hosts.

Ceratophyllus idius Jordan and Rothschild.—Most of the records for this species are from Tree Swallow nests, but it has been recorded frequently from Purple Martin nests

and at least once each from Barn Swallow, House Wren, and bluebird. It occurs across the continent, and should be looked for wherever Tree Swallows breed.

Ceratophyllus lunatus tundrensis Holland.—This is probably not a bird flea, but since it is a member of the bird flea genus and is relatively poorly known, we have included it. Thus far, it appears to be a parasite of weasels, as is the nominate subspecies in the Old World. It is a northern species, records in eastern North America being from the Hudson Bay Region and Quebec. Dr. Holland informs me (in litt.) that his collectors have searched many bird nests in areas where this species occurs without finding it, but have taken numerous specimens from weasels.

Ceratophyllus riparius riparius Jordan and Rothschild.—This subspecies occurs across North America in nests of Bank Swallows and Rough-winged Swallows, and also occurs in Asia. In Scandinavia, it is represented by another subspecies, *C. r. freyi*, while a closely related species, *C. styx*, infests Bank Swallows elsewhere in Europe. Because females with a seventh sternite like that of *C. styx* occasionally occur in North American populations, we have suggested (Benton and Shatrau, 1962) that these populations might be conspecific. Rothschild and Smit (1955), however, consider the two species quite distinct.

Ceratophyllus rossitensis swansoni Liu.—The European form of this subspecies occurs on crows, but early records from North America were from nests of Long-eared Owls. Holland (1954), however, recorded numerous specimens from crow nests in Canada, and it appears that this is the true host. In view of the abundance of crows, it seems remarkable that this flea has been so seldom recorded. It should be sought both in crow nests and in nests of other birds superimposed on old crow nests. It probably occurs across the continent.

Ceratophyllus scopulorum Holland.—This species was discovered in northwestern North America, and has been collected only once in the East. These collections were from nests of Barn Swallows and Cliff Swallows on Kent Island, New Brunswick (Benton and Shatrau, 1962). Whether it occurs throughout the intervening area must be determined by further collecting.

DISCUSSION

It is evident from the paucity of records cited above that the knowledge of eastern bird fleas is extremely limited. Within the past 15 years at least eight new species of bird fleas have been described from western North America, while none have been discovered in the East. Whether or not any new species remain to be discovered, it is certain that much more work is needed to elucidate the distributional patterns and host relationships of these parasites.

Two problems are particularly tempting. No eastern bird flea is known from woodpeckers despite the fact that two species are known in the West, from species which are transcontinental in occurrence. One was described from a Downy Woodpecker (Holland and Loshbaugh, 1958), another from the nest of a flicker (Holland, 1960). There are also woodpecker-infesting species in the Old World. It seems reasonable to expect that eastern species too may be found to harbor fleas when they are carefully studied.

The second problem of special interest is the distribution of fleas in the nests of sea birds along the east coast. Several species of fleas occur in similar

situations along the coast of Britain, in nests of gulls, petrels, puffins, and cormorants which also nest on our side of the ocean. One would expect that extensive collecting from nests of these species would add new flea species to the North American list.

Bird fleas are most commonly found in the nests of hole-nesting or box-nesting species, frequently in large ground nests or those located in moist environments, and less commonly in aboveground nests. All species of swallows appear to be regularly infested, but there are puzzling regional patterns. In New York we have examined the nests of many Barn Swallows without finding a single flea, while nests of the same species from New Brunswick yielded abundant specimens of two species. Further, as indicated above under the discussion of *C. celsus*, the same flea may infest different hosts in different areas, while different fleas may be found on the same host species in different parts of its range. Many more collections will be necessary before we can delineate the extent of these variations or attempt to understand their significance.

TECHNIQUES

Fleas are most abundant in nests, and this fact dictates the most fruitful method of collecting. Recently abandoned nests may be placed in a tightly sealed plastic bag, with data on the host species, date, and locality. The easiest way to secure the fleas is to insert some killing agent into the bag and collect the dead fleas. Since fleas are still emerging from pupation, however, a larger number will be secured if the nest is placed in a Berlese funnel for several days. Still more may be secured if the nest is kept in the bag for several weeks, and fleas are collected periodically by placing the nest in a deep pan and collecting the fleas with an aspirator as they crawl from the nest. Fleas are preserved in 70% alcohol until they can be mounted for identification.

Occasionally fleas are found on birds away from the nest, and young birds in particular may have quite heavy infestations. Bird banders and collectors are in a position to take advantage of this fact to make significant collections. Bird fleas are relatively large and dark colored, and may generally be detected by ruffling the feathers. Fingers or an aspirator may be used to capture these agile parasites, and they may then be dropped in a handy dish of alcohol. On dead birds, fleas may be captured more readily if the bird is placed in a plastic bag and a killing agent added. Even without the killing agent, fleas will usually leave the host or at least move to the outer ends of the feathers as the host cools, and thus are quite easily captured.

IDENTIFICATION

Unfortunately, the preparation of fleas for identification is a rather lengthy process and most ornithologists would not care to go through with it. Further-

more, there is (pending the appearance of Volume 4 of the catalog of fleas in the British Museum) no adequate key to the bird fleas of eastern North America. The best is that of Holland (1951), but this key does not include all species now known to occur in the East. Unless the collector has access to a large library and an extensive comparative collection, he will probably wish to have the fleas identified elsewhere.

Facilities for the identification of fleas are available both at the Entomology Research Institute, Canada Department of Agriculture, Ottawa, and at the United States National Museum, Washington. Vials containing fleas with adequate data are welcomed, particularly if the institution is permitted to keep all or part of the material submitted. In addition, fleas sent to the senior author of this paper will be identified promptly.

SUMMARY

Ten species of bird fleas are known from eastern North America. Each species is discussed, and information is given on the techniques for collecting bird fleas and on facilities for identification of these collections.

ACKNOWLEDGMENTS

The research on which this paper is based has been assisted by Faculty Summer Fellowships from the Research Foundation of State University of New York. We are particularly grateful also to Dr. G. P. Holland, Canada Department of Agriculture, who has read the manuscript and made many valuable suggestions.

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DEPARTMENT OF BIOLOGY, STATE UNIVERSITY COLLEGE, FREDONIA, NEW YORK, AND BETHANY, WEST VIRGINIA, 13 DECEMBER 1963

NEW LIFE MEMBER

Mr. Charles E. Nelson, Jr., of Dousman, Wisconsin has recently become a Life Member of the Wilson Ornithological Society. A graduate of the University of Wisconsin, Mr. Nelson is president of the Waukesha Motor Company. One of the many dedicated amateur ornithologists in Wisconsin, he has been extremely active in the affairs of The Wisconsin Society for Ornithology and has served as President of that organization. Mr. Nelson is married and has two children.

GENERAL NOTES

Roadside raptor count in Colorado.—Incidental to a current long-term study of the Prairie Falcon (*Falco mexicanus*). I have kept records of all raptors seen in a 70-mile-wide plains area extending south from Fort Collins to Colorado Springs, Colorado, immediately east of the Rocky Mountains. Raptors were counted from an automobile cruising county roads on grazing and wheat land. All observations were made before noon on days when the wind was light. A total of 12 counts was made in the periods from late September to February 1962–63 and 1963–64, involving 1,675 miles of travel during the count periods. The data in Table 1 summarize the relative frequencies of the species observed.

TABLE 1

SUMMARY OF THE RELATIVE FREQUENCIES OF RAPTORS OBSERVED

Species	Total number observed	Miles traveled per individual
Rough-legged Hawk (*Buteo lagopus*)[1]	179	9
Marsh Hawk (*Circus cyaneus*)	76	22
Prairie Falcon (*Falco mexicanus*)	63	27
Sparrow Hawk (*Falco sparverius*)	32	52
Golden Eagle (*Aquila chrysaetos*)	32	52
Ferruginous Hawk (*Buteo regalis*)	15	112
Bald Eagle (*Haliaeetus leucocephalus*)	9	186
Pigeon Hawk (*Falco columbarius*)	9	186
Red-tailed Hawk (*Buteo jamaicensis*)	4	419

[1] September count trip omitted since the species is not present in the region in that month.

Three Swainson's Hawks (*Buteo swainsoni*), not included in these data, were seen only in the late September count. They averaged one individual per 16 miles traveled. Four buteonine individuals were not identified with respect to species.

The 63 Prairie Falcons included at least 43 females and 10 males, and at least 20 adults and 21 immatures. Sparrow Hawks, not abundant in winter, appeared to be predominantly males, although nearly half of the 32 individuals were not identified as to sex. Of 20 Golden Eagles identified with respect to age, 14 were adults, and the remainder immatures.

All but one of the 15 Ferruginous Hawks were seen on grazing land east of Colorado Springs and they are less numerous north of that city in winter. Two of nine Bald Eagles were immatures, the others were adults. Four of the nine Pigeon Hawks were clearly of the subspecies *F. c. richardsonii*. The others were seen only momentarily and could not be identified. It has been my experience that the majority of the Pigeon Hawks in this region are of this subspecies.

Allan and Sime (1943. *Wilson Bull.*, 55:29–39) made a similar but more comprehensive count in the Texas Panhandle, and interesting comparisons can be made with their data. In three winter months in 1939 and 1940 they recorded one Rough-legged Hawk per 84 miles traveled; I recorded that species about nine times more frequently. In one winter month they recorded a high of one Ferruginous Hawk per 17 miles traveled, about seven

times more often than I saw them in Colorado. Allan and Sime observed Red-tailed Hawks over five times more often than I did in a "typical" winter month (January 1939). However, their data on Marsh Hawks agree closely with mine; they saw one bird per 20 miles traveled. Prairie Falcons appear to be less numerous in Texas; they saw one bird per 92 miles traveled in October 1939, the high month for that species.

In July, August, and early September 1963, I drove 347 miles in four trips, counting hawks on the plains in the Colorado Springs area. Swainson's Hawks averaged one per 14 miles; Sparrow Hawks, one per 20 miles; Prairie Falcons, one per 58 miles; Red-tailed Hawks, one per 69 miles; and Marsh Hawks averaged one individual per 116 miles.—James H. Enderson, *Department of Zoology, Colorado College, Colorado Springs, Colorado, 13 April 1964.*

A summer movement of Broad-winged Hawks.—On 26 June 1960 we were driving eastward across the north end of Washington Island, an approximately 5 × 5 mile square mass of land some 3.2 miles off the northern tip of the Door County peninsula in northeastern Wisconsin. At about 1000 hours we noticed six hawks soaring to the north of us. These were soon joined by more, and we determined that they were Broad-winged Hawks (*Buteo platypterus*). Minutes later we saw another flock of about 20 birds moving northward along the east shore of the island.

We then drove 1½ miles east to Jackson Harbor at the northeast corner of the island where we found a group of about 80 Broad-winged Hawks spiraling upward. There was a constant stream of new arrivals coming from the south along the eastern shore. The altitude of these arrivals was only 50 to 150 feet, but they soon soared to heights of about 1,500 to 2,000 feet. Periodically a large flock of Broad-winged Hawks accumulated over the Jackson Harbor area. Some of the highest individuals ceased circling and glided off linearly in a north–northeast direction toward St. Martin's Island some 5 miles distant. The remainder of the birds followed in turn until the flock was stretched out in a line perhaps ¼ to ⅓ of a mile long. When the head of this line reached a point about ½ mile off the northern end of the island, circling began anew, but the birds did not seem to be able to gain altitude and soon a line formed leading back to the departure point.

This performance was repeated several times, but periodically segments of flocks broke away and glided off out of sight in a westerly direction. New birds were constantly arriving from the south and rising over our observation point to form or join the soaring flocks. Most of the time the circling flight and the nearly continuous additions and excursions from the flock prohibited an accurate estimate of the number of birds involved. Our highest momentary count was 160 birds, but we suspect that this count should have included about 40 more birds.

It was our impression that the hawks were flying counterclockwise around the island, pausing at the northeast corner to attempt a flight out over the water in the direction of St. Martin's Island. At 1215 hours we counted 76 hawks over Rock Island, a small (1½ square mile) island about 0.3 mile northeast of Washington Island. This group subsequently crossed the water to Washington Island. During a drive through the interior of the island at about 1230 hours we saw eight to ten flocks of 5 to 20 birds each.

It is difficult to estimate the total number of hawks involved in this movement; however, we feel that there was a minimum of 300 and probably as many as 1,000 Broad-winged Hawks over Washington Island that day. In addition, we saw two Red-tailed Hawks (*Buteo jamaicensis*), one Turkey Vulture (*Cathartes aura*), and one Swainson's Hawk (*Buteo swainsoni*). The latter was observed carefully at a distance of about 100

feet. It appeared to be in the juvenal plumage and showed no molt in the flight feathers.

We examined about 75 to 100 of the Broad-winged Hawks closely enough to determine that at least 95% of the birds were subadults. Almost all had conspicuous gaps in the tail and wings. Most individuals had molted the number 4 rectrices, and many also showed a gap in the number 1 (central pair) position. Gaps in the remiges most often appeared at about the number 4 or 5 secondaries, number 4 or 5 primaries and number 8 primaries.

We had seen no Broad-winged Hawks during the late afternoon of the previous day when we drove about 6 miles along the west shore of the island. We have visited Washington Island at about the same time in 5 of the previous 8 years and have seen no more than a few Broad-winged Hawks on any of these visits.

Broad-winged Hawks normally migrate into and through Wisconsin in late April and early May. The fall movement occurs almost entirely in the last half of September. On the basis of nests that we have observed and from data given in Bent (1937. *U. S. Natl. Mus. Bull.* 167:254), breeding individuals of this species should have young on the nest in late June in Wisconsin. Broad-winged Hawks in the juvenal plumage apparently breed only rarely (Burns, 1911. *Wilson Bull.*, 23:139–320). It would appear that this unusual movement was composed of nonbreeding individuals, at least the majority of them subadults.

The U. S. Weather Bureau at Green Bay, Wisconsin, some 80 miles SSW of Washington Island, reported WSW to SW winds of 8 to 18 knots between 0800–1300 hours on 26 June. The previous day was characterized by light westerly winds (mostly less than 10 knots), while NW winds of 15 to 20 knots predominated on 24 June. All 3 days were relatively cool and there was considerable sunshine. These conditions are conducive for the formation of updrafts and hence good flying weather for soaring birds.

The configuration of the Door County peninsula, tapering from 24 to 5 miles wide along its 70-mile length, is such that it would act as a trap for water-shy northbound or northward-drifted migrants. The shore of Lake Michigan acts as a guiding line leading northward to Door County for water-shy eastbound or eastward-drifted migrants. The weather on the day of observation and on the 2 days preceding it, while not atypical for this period, was appropriate for producing a concentration of hawks at the tip of the Door County peninsula. When the birds arrived at the straits separating Washington Island from the peninsula, they apparently had sufficient altitude to cross the 3.2 miles of open water. Once on the wooded island, the birds apparently could not gain sufficient altitude by soaring to permit further easy overwater crossings.

Since the winds were southwesterly on the day of observation, it is impossible to say whether the hawks were actively migrating northward or were being drifted northward. This observation would seem to indicate, however, that a considerable number of Broad-winged Hawks were moving in late June in northeastern Wisconsin. Perhaps many subadult nonbreeding Broad-winged Hawks migrate considerably later than the adults or possibly these individuals spend the summer doing a certain amount of wandering.—Helmut C. Mueller, *Dept. of Zoology, University of Wisconsin, Madison*, and Daniel D. Berger. *Cedar Grove Ornithological Station, Route 1, Cedar Grove, Wisconsin. 25 March 1964.*

Fall foods of Mourning Doves in central Virginia.—This report summarizes the analysis of 238 crops of Mourning Doves (*Zenaidura macroura*) from the Piedmont Region of central Virginia. Crops were collected from doves killed by hunters in Sep-

TABLE 1

FALL FOODS OF 238 MOURNING DOVES IN CENTRAL VIRGINIA

Food item	Aggregate volume	Aggregate per cent
Corn (*Zea mays*)	54.3	45.4
Spurge (*Euphorbia maculata*)	13.4	13.6
Pokeweed (*Phytolacca americana*)	7.3	9.3
Ragweed (*Ambrosia* sp.)	6.2	6.6
Sorghum (*Sorghum vulgare*)	3.6	3.7
Foxtail (*Setaria Faberii*)	2.6	2.9
Paspalum (*Paspalum ciliatifolium*)	2.3	4.8
Crabgrass (*Digitaria sanguinalis*)	2.1	2.3
Three-sided mercury (*Acalypha* sp.)	1.6	1.5
Wheat (*Triticum aestivum*)	1.1	0.6
Spurge (*Euphorbia dentata*)	0.9	0.8
Panicgrass (*Panicum dichotomiflorum*)	0.8	1.1
Mallow (*Sida* sp.)	0.7	0.2
Croton (*Croton* sp.)	0.5	0.3
Crabgrass (*Digitaria Ischaemum*)	0.4	0.9
Milkpea (*Galactia* sp.)	0.3	0.1
Korean clover (*Lespediza stipulacea*)	0.2	1.1
Paspalum (*Paspalum laeve*)	0.2	0.9
Lady's thumb (*Polygonum persicaria*)	0.1	1.3
Vetch (*Vicia* sp.)	0.1	–
Rye (*Secale cereale*)	0.1	–
Pigweed (*Amaranthus* sp.)	0.1	0.3
Panicgrass (*Panicum verrocosum*)	0.1	0.2
Panicgrass (*Panicum* sp.)	0.1	0.3
Buttonweed (*Diodia teres*)	0.1	0.3
Nutrush (*Scleria reticularis*)	0.1	0.1
Unidentified seeds	0.5	1.0
Trace species[1]	0.2	0.4
Animal remains	tr	–

[1] *Paspalum* sp., *P. setaceum*, *Panicum scribnerianum*, *Setaria viridis*, *Sorghum halepense*, *Polygonum* sp., *P. pensylvanicum*, *P. punctatum*, *Rubus* sp., *Cassia* sp., *Oxalis* sp., *Euphorbia corollata*, *Abutilon Theophrasti*, *Cornus florida*, *Plantago* sp., *Erechtites hieracifolia*.

tember, October, and November 1959. Materials in the crops were analyzed by the aggregate volume method recommended by Martin, Gensch, and Brown (1946. *J. Wildl. Mgmt.*, 10(1):8–12). The writer acknowledges the generous assistance of Neil Hotchkiss, Patuxent Wildlife Research Center, and Professor A. B. Massey, Virginia Polytechnic Institute, in the identification of certain food items.

The seeds of 42 plants in the crops were identified (Table 1). Sixteen of these were present as trace amounts. Animal remains were insignificant. Eight plant species comprised 92% of the sample. Three families, Gramineae, Euphorbiaceae, and Phytolaccaceae, include all but 9% of the sample. Four kinds of cultivated grains were taken,

and corn was by far the most important single item of the doves' food. These results are in general agreement with the findings of similar studies in other regions.—James L. Chamberlain, *Department of Biology, Randolph Macon Woman's College, Lynchburg, Virginia, 13 April 1964.*

Southerly occurrence of Clark's Nutcracker.—The very recent paper "The 1961 Irruption of the Clark's Nutcracker in California" by Davis and Williams (1964. *Wilson Bull.*, 76:10–18) reminded us of a 1961 observation of a Clark's Nutcraeker that should be worthy of public record.

On 16 November 1961, one adult Clark's Nutcracker (*Nucifraga columbiana*) was seen flying southeasterly over Mexican Highway 40 in the pine–oak forests of the Sierra Madre Occidental of southwestern Durango a few miles to the east of a highway monument known as Puerto Buenos Aires. This species has been observed for years in the Sierra Nevada of California by all of us, so it was readily identifiable. Other speeies seen in this area, the Steller's Jay, Mexican Chickadee, Pigmy Nuthatch, Ruby-crowned Kinglet, Gray Silky Flycatcher, Green-tailed Towhee, and Chipping Sparrow, were all, for the most part, similar to those species seen in nutcracker range in California.

This location lies over 500 miles to the south of El Paso, Texas, and thus constitutes a significant range extension in the Sierra Madre Occidental from previously known Mexican records in Baja California, Sonora, and Nuevo Leon ("Distributional Cheek-List of the Birds of Mexico," *Pac. Coast Avifauna*, 33:119).

The timing of this observation fits nicely with the nutcraeker irruption dates reported by Davis and Williams, for the irruption was well under way into the southern United States by late September and early October 1961 (loc. cit.:10). Further, during this irruption which lasted into the spring of 1962, nutcrackers were seen far from their normally known range in such states as Kansas, Missouri, Oklahoma, and Texas (loc. eit.: 13).—Fred G. Evenden, *7805 English Way, Bethesda, Md.*, and A. J. and L. B. Argante, *7246 Fair Oaks Blvd., Carmichael, California, 10 May 1964.*

Attempted Robin predation by crow.—On an early June (1953) afternoon in a wooded area of the U.S. Naval Training Center, Bainbridge, Maryland, I observed a flying Common Crow (*Corvus brachyrhynchos*) being attacked by two, possibly three birds. Because the crow appeared to be carrying something in its beak, I observed it earefully. It alighted in the top of a tall (40–50 feet) deciduous tree and paused a few moments before flying away again. In leaving the branch, it lost considerable altitude and suddenly dropped the object in its beak. As I picked up the young bird, a Robin (*Turdus migratorius*), I noted the time as 1520. Subscquently, I found the bird to weigh 53.7 g. It seemed dazed and paralyzed by the fall, and died at 1645. Hartman (1946. *Auk*, 63:59) gives the mean body weight of 14 adult Robins as 79.7 ± 9.1 g.

These notes became misplaced during my return to civilian life following active Naval duty and only recently came to light. It is hoped that this delay in no way invalidates the observation.—Kenneth W. Prescott, *New Jersey State Museum, Trenton, 23 December 1963.*

House Sparrow with a bill abnormality.—An unusual bill abnormality was noted in a female House Sparrow (*Passer domesticus*) colleeted by W. Hesse at his banding station in Burnaby, British Columbia on 20 October 1963. The maxilla was strongly decurved, and its right side had grown downward, resulting in a lateral surface with the

FIG. 1. Bill abnormality in House Sparrow. Note the right lateral downgrowth and the two projections of the mandible.

tomium paralleling the eulmen to the tip of the bill (Fig. 1). The mandible consisted only of two short, keratinized, anterior projections from the rictal region. There was no medial connection between these projections and both were much twisted (Fig. 2). The tongue was somewhat dried but otherwise appeared normal. The exposed eulmen measured 13.6 mm. Culmen lengths of 15 females in the collections at the University of British Columbia ranged from 10.8 to 12.2 with mean and standard deviation of 11.78 ± 0.44 mm. The bird appeared to be in good health, weighing 32.6 g (after having been frozen for 2 months). The crop and stomach were filled with grain, and a small amount of fat was present about the feather tracts. The bird was in a condition of molt; the remiges being still partly contained in sheaths. The skull was fully granulated. The bill abnormality was noticed post-mortem, thus, the methods of feeding and preening were not observed. The specimen is now No. 11567 in the U.B.C. research collection.

Bill anomalies in wild passerines are probably regular in occurrence. Most of those described involve growth of the keratin structure of the bill in such a way that the abnormal structure is superimposed on a basic bill structure. The present bird is unique in having most of the lower mandible entirely absent. Bill abnormalities involving overgrowth and decurving of the maxilla, often crossing the mandible, have been described in the Red-winged Blackbird (*Agelaius phoeniceus*) (Morton, 1963. *Wilson Bull.*, 75: 281), Starling (*Sturnus vulgaris*) (Dady, 1951. *Brit. Birds*, 44:60; Warham, 1951. *Brit. Birds*, 44:349), and in a number of the British titmice (Howard, King and Collenette, 1951. *Brit. Birds*, 44:350–351). Similar deformities have been reported among

FIG. 2. Bill abnormality in House Sparrow. Note the right lateral downgrowth and the two projections of the mandible.

nonpasserines (Batts, 1954. *Wilson Bull.*, 66:142). The frequency of occurrence of bill anomalies is suggested by Hick's (1934. *Bird-Banding*, 5:103–118) study of Starlings in Ohio, where an examination of 10,000 birds revealed 38 with abnormal bills.

Most authors in describing bill abnormalities have speculated on the problems of feeding, but few have mentioned the possible difficultics involved in preening. Shelley (1935. *Bird-Banding*, 6:35–36) mentioned that a Downy Woodpecker (*Dendrocopos pubescens*) with half of the upper mandible broken off had difficulty in preening away the parts of the feather sheaths during molt. In the present bird, the normal patterns of preening were probably ineffective since the remiges had parts of the feather sheaths still encircling the vanes.

It is apparent that bill deformities may result from accident, but many probably occur through abnormal developmental processes. West (1959. *Auk*, 76:534–537) has shown that bill and claw keratin structural deformities can be induced in the Tree Sparrow (*Spizella arborea*) by high temperature. Howard (1951. *Brit. Birds*, 44:350) described the development of an abnormal bill in a 4-year-old Great Tit (*Parus major*) during each of two successive winters. The impediment was shed during the intervening period, and the author suggests that this may have been in part due to vigorous bill-wiping. The abnormality of the present bird involved not only the keratin but also the skeletal structure.—DOUGLAS D. DOW, *Department of Zoology, University of British Columbia, Vancouver 8, B.C.*, AND WERNER HESSE, *7217 16th Avenue, Burnaby 3, B.C., 19 March 1964.*

***Tanagra minuta*, an addition to the Mexican list.**—While examining bird skins in the collection of the Moore Laboratory of Zoology, Phillips found in a series of *T. affinis* a previously undetected specimen of the White-vented Euphonia, *T. minuta* Cabanis. The specimen, apparently an adult male, is labeled Palenque, Chiapas, altitude 210 m, 9 May 1946, and was taken by Mario del Toro Avilés. It represents the only known record of this species from Mexico, and an extension of the species' range 300 km northeastward from the former northernmost known locality of occurrence, at Cobán, Guatemala. The bird is No. 43767 in the Moore collection. According to Griscom (1932. *Bull. Am. Mus. Nat. Hist.*, 64:373), *T. minuta* is ". . . exceedingly rare north of Costa Rica," and seemingly only two specimens have been reported (Salvin and Godman, 1883. *Biologia Cent.-Am.*, Aves, 1:259) north of there—both from Cobán. It seems possible, however, that the species' seeming rarity may result from the failure of collectors to search for it, in distinction to the very similar *T. affinis*, which is so common in many parts of Mexico and Central America. For this reason we deem it desirable to call attention to the field characters of *T. minuta* that might distinguish it from other species. Females are readily distinguishable by a broad band of dull yellowish crossing the breast and forming a marked contrast to the grayish throat and abdomen. Males are much more difficult, but might possibly be distinguished from *T. affinis* by their more tawny, less purely yellow chest and by the white crissum, a character which *minuta* shares with no other species of *Tanagra* in its northern range. In the hand, *T. minuta* is readily distinguished by its less swollen mandible, the outline of which is nearly straight. In direct comparison with *T. affinis*, *T. minuta* is distinctly smaller. Although the area of Palenque, Chiapas, is one in which this species might be expected to occur, it is still desirable that ornithologists having an opportunity to visit there, or in other similar habitats in Chiapas and Tabasco, attempt to learn more of the distribution and abundance of this supposedly rare euphonia.—Allan R. Phillips, *Instituto de Biología, Universidad Nacional Autónoma de México, México, D.F.*, and John William Hardy, *Moore Laboratory of Zoology, Occidental College, Los Angeles, California, 6 June 1964.*

Birds feeding on an ant mating swarm.—From 1600 to 1900 hours (DST) on 23 August 1961, we watched 13 species of birds feed on a mating swarm of *Lasius alienus* (Foerster), a common Holarctic species of ant. We first noted this activity through the aerial feeding of Starlings over a large grassy field on the Drumlin Farm Wildlife Sanctuary, Lincoln, Massachusetts. A brief trip around Lincoln showed that the mating swarm was restricted to this Drumlin Farm field; later, a few ants were seen in another part of Lincoln, 1 mile to the north, and several swarms were noted in Wayland, at distances varying from 1 to 3 miles southwest of Drumlin Farm.

During the period of observation there was a solid overcast (a few light showers), the temperature was in the lower 60's, and it was essentially windless.

SPECIES ACCOUNT

Nighthawk (*Chordeiles minor*).—A flock of 19 first appeared over the field around 1615, fed for a period of 15 or more minutes, and gradually drifted south, out of sight. At 1700 this same flock was seen about ½ mile east of the field, flapping and gliding in a manner usually associated with migratory flight. However, at 1730, the same (?) flock reappeared over the field and for a brief period resumed their characteristic feeding flight. Feeding altitude in this species was highly variable.

Chimney Swift (*Chaetura pelagica*).—A maximum of 15 swifts fed over the general

area of the field between 1600 and 1730. Most fed between 200 and 300 feet; occasionally one or two came lower to treetop level (50–60 feet).

Eastern Kingbird (*Tyrannus tyrannus*).—At least two were seen fly-catching from the tops of trees lining one edge of the field.

Swallow sp.?.—Fleeting glimpses of several swallows with white bellies were obtained but identification was not made.

Barn Swallow (*Hirundo rustica*).—There were relatively few swallows in the aggregation and most were of this species (8–10 max.). This and the previous species fed at heights over 200 feet.

Purple Martin (*Progne subis*).—Three martins (one adult male and two immatures or females) appeared with the Nighthawk flock and remained in the area for 10–15 minutes. They fed at varying altitudes but stayed mainly below the swallows and Nighthawks.

Blue Jay (*Cyanocitta cristata*).—One was seen feeding low (between the trees) in an apple orchard adjacent to the field. Its feeding behavior consisted largely of level flight, with a slight veering after a capture. Later, about ¾ mile away in Wayland, two jays were seen feeding among the branches of a dead tree, hopping from branch to branch with only short fly-catching flights between the branches.

White-breasted Nuthatch (*Sitta carolinensis*).—At 1720, a nuthatch appeared in a tall elm on the upper slope of the field and immediately started fly-catching. It would sally forth, catch an ant, then return to either the elm or the roof of an adjacent building. This was repeated many times.

Catbird (*Dumetella carolinensis*).—Along the edge of a marsh in Wayland, two were seen to hop out of the bushes into a dead tree. One hopped almost to the top of the tree and flew; after a short zigzag flight, it veered upwards, caught an ant, and continued flying to some distant bushes.

Cedar Waxwing (*Bombycilla cedrorum*).—Several were seen fly-catching over a lawn adjacent to the field.

Starling (*Sturnus vulgaris*).—When first noted the Starlings were circling and gliding in a swallow-like manner over the full extent of the open field. This activity was maintained (for 15 or more minutes) until the Starlings were supplanted in the air space over the field by the Nighthawks, martins, and swallows; the Starlings then resorted to fly-catching from the tops of trees bordering the field. After the Nighthawks drifted away, the Starlings resumed their flap and glide (swallow-like) feeding over the field. This relinquishing of the air space over the field by the Starlings was repeated an hour later when the Nighthawks reappeared momentarily.

By 1745 the number of feeding Starlings had lessened and by 1753 there were none feeding in the Drumlin Farm area. However, at 1805 in an adjacent township (Wayland), flocks of Starlings were seen going to roost. One flock perched at the top of a tall elm numbered around 100 birds and was being constantly augmented by small flocks flying in from the NE; many of these perched birds were fly-catching.

Both types of Starling feeding behavior were at relatively low altitudes, between 50 and 100 feet.

Red-winged Blackbird (*Agelaius phoeniceus*).—At 1710 an immature male flew into the top of a tall oak adjacent to the field and began fly-catching. It continued this activity for at least 15 minutes. Later, at 1830 in Wayland, a flock of Red-winged Blackbirds and grackles were seen atop a dead tree in the middle of a marsh; all were actively fly-catching.

Common Grackle (*Quiscalus quiscula*).—One was seen fly-catching from the same

grove as the immature Red-winged Blackbird at Drumlin Farm, and grackles were part of the blackbird flock seen fly-catching in Wayland.

Seven species of birds which did not feed on the ants were noted passing through or pausing momentarily in areas where ants were flying. These species were Sparrow Hawk (*Falco sparverius*), Mourning Dove (*Zenaidura macroura*), Yellow-shafted Flicker (*Colaptes auratus*), Robin (*Turdus migratorius*), House Sparrow (*Passer domesticus*), Brown-headed Cowbird (*Molothrus ater*), Song Sparrow (*Melospiza melodia*).

DISCUSSION

Although many species of birds are known to be opportunists in feeding situations such as this, we feel that documentation of such behavior is of value. In addition to the above species account there are four points in need of further clarification.

First, the supplanting of the Starlings by the Nighthawks over the field was especially pronounced. One can only speculate on whether this was a case of mistaken identity (confusing the Nighthawk shape with that of a falcon) or whether it represented a dominance order. It appeared to us that the supplanting took place without any overt threat or contact. Of further interest in this connection is the adaptability of the Starlings as shown by their shifting from a swallow-type feeding behavior to a fly-catching feeding behavior after being supplanted.

Secondly, among the birds utilizing the temporarily abundant food supply were species which regularly feed on the wing (Nighthawk, Chimney Swift, Eastern Kingbird, Barn Swallow, and Purple Martin), some that do so irregularly (Cedar Waxwing and Starling), and others which rarely display this type of feeding behavior (Blue Jay, White-breasted Nuthatch, Catbird, Red-winged Blackbird, and Common Grackle). That no fewer than five species that rarely fly-catch were seen to do so gives rise to speculation concerning the motivation of this aberrant feeding behavior: Was it the extraordinary abundance of this easily obtained food? Or was it a matter of social stimulation, at least in the case of the Drumlin Farm birds? This leads us to the third point.

Our attention was first called to the mating swarm by the activities of the Starlings, and we subsequently noted the other participating species. However, it was the Starling that persisted throughout the period of observation, the other species being more transitory in their feeding. Even the aerial feeders remained in the area for only a short time. Could it have been coincidence when at 1800, after the Starlings had left for their roost, that *all* feeding activity ceased, even though we could detect no apparent reduction in the number of ants? It appears to us that at Drumlin Farm this mass utilization of a temporarily abundant insect food was stimulated by the feeding activities of the Starlings.

Finally, mass utilization by the birds would appear to exert extreme selection on the queen ants, because of their much larger size. Such selection would begin with the emergence of the winged females from their natal colonies, continue during their nuptial flights, and end with the dropping of the fertilized queens to the ground. The extreme vulnerability of the ants would appear to lessen once the queens reach the ground, for we saw no instances of predation on grounded ants.

We would like to thank Professor E. O. Wilson for identifying the ants that we collected.—James Baird, *Massachusetts Audubon Society, Lincoln, Massachusetts* and Andrew J. Meyerriecks, *University of South Florida, Tampa, Florida, 24 July 1964.*

ORNITHOLOGICAL NEWS

The National Science Foundation announces that the next closing date for the receipt of proposals for basic research in the Life Sciences is 1 May 1965. Proposals received prior to that time will be reviewed at the summer meetings of the Foundation's advisory panels, and disposition will be made approximately four months following the closing date. Proposals received after 1 May will be reviewed following the fall closing date of 15 September 1965.

Inquiries should be addressed to the Biological and Medical Sciences Division, National Science Foundation, Washington, D.C. 20550.

Dr. Douglas James is seeking information concerning the annual breeding population levels of Eastern Bluebirds and thus would like to contact people who have established a number of bluebird nesting boxes. Anyone who is maintaining a series of nesting boxes and is interested in cooperating in the annual breeding survey of Eastern Bluebirds, should write Dr. James at the Department of Zoology, University of Arkansas, Fayetteville, Arkansas.

The Secretary of the International Commission on Zoological Nomenclature announces the possible use of the plenary powers of the Commission in connection with the following cases of interest to ornithologists: (1) Validation of four specific names from the work "Ornithologia Britannica," 1771, *Z.N.* (S) 1636; (2) Suppression of Moehring's work "Geslachten der Vogelen," 1758, *Z.N.* (S) 1637; (3) Validation of *Cacatua* Brisson, 1760, *Z.N.* (S) 1647; and (4) Validation of *Anthus roseatus* Blyth, 1847, *Z.N.* (S) 1654. Any zoologist wishing to comment on any of these cases should do so in writing before 26 May 1965 to: The Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.

The National Referral Center for Science and Technology at the Library of Congress announces the publication of "A Directory of Information Resources in the United States: Physical Sciences, Biological Sciences, Engineering," a 356-page book containing narrative descriptions of the subject specialization, information services, and publications of some 1,100 organizations and institutions throughout the United States. Copies may be purchased at $2.25 each from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

ORNITHOLOGICAL LITERATURE

PESTICIDES AND THE LIVING LANDSCAPE. By Robert L. Rudd. University of Wisconsin Press. Madison, 1964: 6¼ × 9½ in., xiv + 320 pp., 22 tables, 1 fig. $6.50.

This critically important book is a Conservation Foundation Study. The author is currently an Associate Professor of Zoology at the University of California, Davis. He has a broad background in ecology and wildlife management which includes four years of research on the effects of pesticides on wildlife populations in California. Mr. Rudd modestly identifies the purpose of his book as ". . . to explain to the serious reader, particularly one with responsibilities relevant to the subject, what the kinds of hazards resulting from chemical pest control are." The author has certainly created a work which admirably achieves this goal; I suspect that a much wider audience will find his book to be immensely worthwhile reading. The scope of this work goes beyond the usual concept of pesticides and includes an appraisal of control programs aimed at birds and mammals. This is a well-organized section with a good historical background and a summary of recommendations.

Rudd makes his own position clear at the very beginning. Granted that man can mold much of his environment to suit his own immediate needs, he is still not independent of the ecological consequences of his actions. The author suggests (page 4) that "Concomitance . . . living with natural forces . . . rather than dominance is the only route to enduring self-interest." Rudd is aware of the value of pesticides and states (page 4), "We realize, for example, that successes in pest control have, along with other technological applications, greatly changed the yields in American forest, grazing, and crop environments." Alongside the unquestioned values of pesticides, Rudd poses a list of objections which include the following points: (1) Pesticides are really biocides which kill other forms of life along with target species. (2) The application of pesticides is often not restricted to target species or target area. (3) We are not paying enough attention to alternative means of crop protection. (4) The problems of delayed toxicity, secondary poisoning, storage, and concentration in food chains are now well enough known to raise serious questions as to the widespread use of many of our common pesticides.

Following his introductory chapters which attempt to present the pesticide problem in capsule form, the author proceeds with a section containing four chapters which are a review and summary of chemicals used in the control of pests. This material is presented in nontechnical terms understandable to the layman. It contains a description of the kinds of pesticides, including a table of acute and chronic oral toxicities of some common pesticides. As elsewhere in the text, his treatment is thorough, but not so technical as to be obscure to an interested lay reader. The book continues with a discussion of pest-control methods and programs with special attention to local versus mass control programs. Under "Loss, Cost, and Gain," Rudd analyzes the justification of pest control. He concludes this section with a consideration of the basis of pesticide legislation which contains some very interesting discussions of the introduction of early insect pests and subsequent legal measures which have been aimed at these problems.

The remaining three-quarters of the book is an ecological discussion of the effects of pesticides on man, wildlife, and the environment. From the vantage point of his own extensive experience in pesticide–wildlife relationships, Mr. Rudd constructs a very impressive review of the effects of pesticides on invertebrates, cold-blooded vertebrates, and warm-blooded vertebrates. He includes discussions of resistance to insecticides, pesticide residues, predator–prey relationships, and the highly interesting phenomenon of substitution of one closely related form for another following pesticide treatment.

The concluding chapters are concerned with the transfer of pesticides in food chains, secondary poisoning, and changes in faunal composition following pesticide treatment. Some of the most interesting reading in the book appears in the author's examples of pesticide transfer and concentration in aquatic and terrestrial communities. Rudd is very skillful in bringing together a fascinating array of information to document the phenomenon of "biological concentration" which is possibly the most serious and widespread problem introduced with the use of chemically stable pesticides.

It is perhaps inevitable that this book will be compared to the late Rachel Carson's "Silent Spring." A comparison is not easily made, however, since the audience of each author is quite different. Silent Spring was supported by years of scholarly research but did not include the use of citations within the text. This allowed Miss Carson to use a more free-flowing style of presentation aimed at the widest possible audience. Silent Spring was a unique literary polemic, whereas "Pesticides and the Living Landscape" is a relatively dispassionate examination of the evidence now at hand. Indeed, at several points, Mr. Rudd is so cautious in stating his conclusions as to cause some of us to squirm, wishing, as it were, that we might evoke a more positive statement from him. This is not to question the author's courage or convictions. He has plenty of both and makes his recommendations with force.

It is interesting in retrospect to see the change which the last few years have brought to the field of pesticides and the environment. Many of the ideas presented in Silent Spring, which were so hotly contested at the time, now appear in Mr. Rudd's book more in the vein of accepted fact than in controversy.

A comparison of the content of Pesticides and the Living Landscape and Silent Spring readily convinces one of the speed with which this field is moving and emphasizes the need for a fresh statement of material now at hand. Indeed, with a press deadline of September 1963, Mr. Rudd, like Miss Carson before him, has missed by a few months the appearance of material which would have dramatically fortified his discussion of pesticide residue concentration in food chains. The effect of DDT in knocking out reproduction in New York's Lake George lake trout is a case in point. The growing evidence that our own national symbol, the Bald Eagle, is a likely victim of the same phenomenon would also have made a very interesting contribution to Mr. Rudd's discussion.

In criticism of Pesticides and the Living Landscape, I have no broad comments to make. I like the wide scope which the author has given to this work; he clearly states the presuppositions which are the foundation of his recommendations. He is cautious in treating objective material and realizes when he is making subjective judgments. In a more detailed examination, a check of the citations in the last half of the text against the references cited revealed no discrepancies. In twenty references pulled at random from the bibliography and checked against original journal entry, only one insignificant typographical error was detected. The only error in reference interpretation which I noted occurred in a citation wherein Rudd implies that lichens are the principal food of lemmings in the Alaskan Arctic. To my knowledge, neither the brown nor the collared lemming makes any significant use of lichens for food. The point is a small one, however, and does not subtract from the validity of the author's use of this otherwise excellent example.

Moving to the more subjective matter of literary style, Rudd's writing is for the most part pleasing and varied; however, he occasionally lapses into muddy sentences and in one instance (page 179) employs a run-on sentence which keeps the reader on edge for thirteen lines. Furthermore, he tends to very much over-use the word "moreover" to the

near exclusion of other connectives. The author's choice of words is also sometimes puzzling as in the response to rhetorical questions on page 178: "Are we producing 'biological deserts'? Yes; pest control, where it *assists* in simplifying habitats, *accomplishes* these things" (italics mine).

These are small and carping complaints on what is over-all a handsome scientific work. We are deeply indebted to Mr. Rudd for bringing his experience and scholarly industry to bear upon a problem which is so vital to us all. The closing chapter "Retrospect and Prospect" is a summary of his point of view and a forceful charge to all conscientious citizens on the problems of pesticides in our environment. Everyone interested in wildlife conservation will find this book to be stimulating and very rewarding reading.—Daniel Q. Thompson.

Check-list of Birds of the World. A continuation of the work of James L. Peters. Volume 10. Edited by Ernst Mayr and Raymond A. Paynter, Jr., Museum of Comparative Zoology, Cambridge, Mass., 1964: 6½ × 9¼ in., ix + 502 pp. $10.00.

In my review of Volume 9, the first of the "post-Peters" volumes of this check-list (1960. *Wilson Bull.*, 72:415, 416), I emphasized the importance of the series as a basic reference work in ornithology. I reemphasize this point now, with the appearance of Volume 10, for an excellent reason. The "Check-list of Birds of the World" is a publication project, now nearing completion, which merits the support of all ornithologists, whatever their specialties. No matter how critical we may be of matters of detail in individual volumes (as I shall be, below), it is to our best interests to have available a complete, up-to-date list of the avifauna of the world. The nontaxonomist can use it as a guide to the names of the birds he is studying; the taxonomist can use it as a jumping-off place for controversy. This would seem so self-evident as to be a waste of space to repeat, but I am informed by the editors that the sales of recent volumes of the Check-list have been far below expectations. It is true that, for many nontaxonomists, a set of "Peters" might appear to be an unjustifiable *personal* expenditure, but we should all certainly see to it that our *libraries* purchase the volumes as they appear. Dr. Mayr writes me, however, that surprisingly few libraries subscribe to the set. I find this both shocking and puzzling. It is quite possible that some potential purchasers, both individuals and libraries, have hesitated to buy current volumes because of unavailability of some of the earlier volumes, making the assembling of a full set a matter of paying premium prices to secondhand book dealers. This drawback has been remedied, and all but one of the "out-of-print" volumes are being reprinted. The sole exception is Volume 1, of which a revised edition is in preparation. The Check-list is financed through a revolving fund, so the appearance of the remaining volumes rests in large part on sales of those now in print. I urge those readers of *The Wilson Bulletin* who do not wish to buy personal copies of the Check-list of Birds of the World to recommend purchase of a set by their institutional or local libraries. And should the price of these volumes seem high, I strongly recommend reading the article entitled "Scientific Publishing," by Tinsley Crowther (1964. *Science*, 144:633–637).

Let no one misunderstand; I do not take this position because I believe the Check-list to be perfect and its authors infallible, so that nontaxonomists may take its classifications and its statements of distribution as being the last word. Far from it. But the usefulness of the work as a whole so far outweighs the importance of the presence in its pages of errors of fact or judgment that its completion should be encouraged in any way possible. The authors and editors of this check-list receive no pay or royalties for their work on the project, and deserve our support and our gratitude.

We turn, then, to Volume 10. It is the product of only three authors, in contrast to the eleven represented in Volume 9 and the six in Volume 15. The "chapters" on the accentors (Prunellidae) and thrushes (Turdinae) were prepared by S. Dillon Ripley; the logrunners (Orthonychinae), babblers (Timaliinae), parrotbills (Panurinae), picathartes (Picathartinae), and a group of "genera sedis incertae" by Herbert G. Deignan; and the gnatcatchers and their allies (Polioptilinae) by Raymond A. Paynter, Jr. The latter author, in an addendum, also covers the genus *Psilorhamphus*, which Peters had intended to include with the Sylviidae but which is now believed to belong to the Rhinocryptidae (already covered in Volume 7).

It is well known that the editors of the present volume favor the concept of a huge family Muscicapidae, to include all of the so-called "Old World insect eaters" (thrushes, Old World warblers, Old World flycatchers, babblers, etc.). This shift upwards by one taxonomic rank in the hierarchy has had some odd side effects in the present volume. For one thing, the family name Muscicapidae does not appear on the title page, so that it might well appear to the uninitiated that the Turdinae, Timaliinae, etc., are all considered subfamilies of the Prunellidae, the first name on the list and the only family name given. The thrushes (Turdinae) are not further subdivided (although, as mentioned earlier by Ripley [1952. *Postilla*, no. 13], there appear to be at least two natural subgroups of thrushes). This places the thrushes as a whole at the same taxonomic level as each of a number of groups usually placed one level below. Delacour (1946. *L'Oiseau et la Rev. Fr. d'Orn.*, 16:7–36), for instance, recognized six "tribes" within the Turdinae, also placing at the tribal level the gnatcatchers and the parrotbills, which each have full subfamily rank (thus equal to the thrushes as a whole) in the present Check-list volume. The gnatcatchers and their allies have always been placed among or adjacent to the "Old World warblers"; the AOU Check-list, for instance, lists three subfamilies of Sylviidae in the sequence Sylviinae, Polioptilinae, Regulinae. This is not to argue that the AOU sequence is correct, but to suggest that the Polioptilinae might more logically and conveniently have been included in the next volume, which will presumably contain the rest of the "Old World warblers."

This volume includes several genera of birds whose taxonomic affiliations have been the subject of debate. When birds have been shifted about at the family or subfamily level, it would have been useful for many readers to have a footnote mentioning this fact, even though the author may believe the matter is settled once and for all. For example, Ripley includes among thrushes the genera *Erythropygia*, *Namibornis*, and *Zeledonia*; footnotes might have explained that certain other standard references place these genera in the Old World warblers, the Old World flycatchers, and a monotypic family, respectively. One of the most puzzling of oscine genera, *Picathartes*, is given a subfamily to itself (thus, again, making it the hierarchal equivalent of all of the thrushes put together), while in what is to me a new departure in such a check-list, Deignan admits frankly that he is baffled by the genera *Malia*, *Myzornis*, *Horizorhinus*, *Oxylabes*, and *Mystacornis*. These are grouped together as "genera sedis incertae," but are sandwiched between the Timaliinae and the Panurinae, which would seem to imply at least some notion as to their "sedis." This solution, although unorthodox, is perhaps preferable to elevating problem genera into monotypic subfamilies as with *Picathartes* (and *Pityriasis* in Volume 9).

This volume differs in several respects from the first two "post-Peters" volumes. Those were published in Denmark, while with Volume 10 the entire manufacture has been returned to the United States. Although the Danish printers did an excellent job, Dr. Paynter informs me that duty and transportation costs more than offset the saving effected

by somewhat lower printing costs in Denmark, and the convenience of using a printer near at hand is obvious. The type in Volume 10 is a larger size than that used earlier; as a purely subjective judgment, I find the new typography no more readable and rather *less* attractive to the eye. There have been several changes in typography since this series began in 1931; I personally find that used in Volume 7 (1951) the most pleasant. The binding of Volume 10 is a distinct improvement from the standpoint of durability. It is a strong unadorned library buckram with rather stark lettering on the spine; Volume 10 is thus, amusingly, "pre-rebound," being an excellent match for those earlier volumes which have been rebound in heavy cloth by many libraries.

The controversial use of English vernacular names for some but not all species, instituted in Volumes 9 and 15, has been abandoned completely, following the advice of ten of "the twelve authors of this and forthcoming volumes." This represents a complete reversal of position from that expressed in the introduction to Volume 9, which states that "the majority of the collaborators and the editors felt that the inclusion of the English name added sufficiently to the usefulness of the volume to compensate for the inevitable criticism." Some will regret the decision to drop the use of English names; my own position, expressed in reviews of the two previous volumes, was that such names should be used for all species or none. The editors opted for the latter, and in view of the amount of work involved in getting out this check-list *without* having to arbitrate an English name for every species, I find myself completely in sympathy with their decision.

This volume well illustrates one of the problems of multiple authorship. There are distinct differences among the authors in taxonomic approach, style, treatment of details, thoroughness, and accuracy. There is space to mention only a few. Paynter places question marks, without explanation, before the names *Polioptila caerulea gracilis* and *P. plumbea cinericia*, presumably because he is not convinced as to the validity of these races but lacks sufficient evidence to synonymize them. Deignan also uses question marks, but is explicit as to his misgivings; thus ?*Babax waddelli lumsdeni* Kinnear is "doubtfully distinct from *waddelli*." One variation in treatment brings up a policy question: in citing type localities, should old geographic names be given verbatim, or changed to accord with current usage? For example, on page 258 Deignan cites the type locality of *Drymocataphus cleaveri* Shelley, 1874, as "Fanti region, Ghana." There was, of course, no such political entity as Ghana in 1874; the locality was given by Shelley simply as "Fantee." I believe that the reader is entitled to know just what identification or restriction of type locality has been made by a Check-list author, and I favor the treatment employed by Paynter, in which the original type locality is given verbatim, with explanation in square brackets. Thus, on page 449, Paynter cites the type locality of *Polioptila caerulea cozumelae* Griscom as "Isla Cozumel, Yucatán [= Quintana Roo], Mexico."

Another point having to do with geography may be noted here. Deignan not uncommonly gives the range of a form in terms of political subdivisions or local regions without mentioning the name of the country, or islands without mentioning their archipelago. As an example of the latter, on page 322 the range of *Macronous gularis ruficoma* is given simply as "Bangka and Billiton." The words "off Sumatra" should be added not only to orient readers not familiar with the geography of southeast Asia, but also because there is another Bangka Island north of Celebes. Many readers will be hard put to remember that Tongking is in Vietnam, not in China, or that Manipur is in India rather than in Burma or Pakistan. Incidentally, I certainly cannot fault the editors for not having been able to monitor consistency in spelling of geographic names; I note that Ripley (cf. page 159) uses the spelling "Tonkin" for what Deignan (cf. page 373) calls "Tongking." Deignan frequently adds, in square brackets, the latitude and longitude of

type localities. This is a distinct service, although he has performed it rather inconsistently; thus on page 344 he provides the coordinates of Mombasa, Kenya, one of the most important port cities of Africa, while on the same page he fails to locate for us Ali Amba, Ethiopia, which I am unable to find in the excellent *London Times* "Atlas of the World."

In this volume, as in Volumes 9 and 15, a footnote at the beginning of each family or subfamily lists ornithologists by whom that portion of the Check-list was read in manuscript. Volume 10 is the first in which my name appears among these; I read all manuscripts except Ripley's on the thrushes. Corrections and suggestions based on such readings are turned over to the authors by the editors, and the degree of attention paid to these lists seems to be highly variable. To give but one small example, the misprint on page 326, "Mount Lobu" for Mount Lobi, appeared in the manuscript which I read, and I duly called attention to it, but it has been perpetuated in the published version. The user of the Check-list unfortunately cannot know either with what degree of care (or finicalness, if you prefer) each "reader" performed his volunteer task, or to what extent the resulting corrections and suggestions have been utilized.

The introduction to the present volume summarizes the editors' concept of the scope of responsibility of editors and authors, respectively, of this check-list. Conspicuously absent from this discussion is the subject of nomenclature, in its legalistic aspect. There has been much inconsistency of treatment here. The editors have allowed the author to have his own way, presenting their opinion in a dissenting footnote (Panurinae vs. Paradoxornithinae, page 430); they have overruled the author but permitted *him* a dissenting footnote (*Horizorhinus* vs. *Cuphornis*, page 428); or they have changed the author's usage (known only to those who have seen the manuscript) *without* including any such written dissent (*Pnoepyga* vs. *Microura*, page 293). The latter case is an especially interesting one, as the editors cite Opinion 695 [of the International Commission on Zoological Nomenclature] as the authority for rejecting as a nomen oblitum the earlier name *Microura*. Although Opinion 695 was signed on 12 June 1963, it was not *published* until 25 March 1964 (*Bull. Zool. Nomen.*, 21:33), eight days *after* the publication of this volume of the Check-list! However, this case is obviously one about which the senior editor felt strongly, to the extent that he permitted himself to characterize authors expressing a legitimate preference for strict priority in this and similar cases as advocating "nomenclatural anarchy" (1963. *Bull. Zool. Nomen.*, 20:17), a patently absurd charge.

In sharp contrast to this scrupulous devotion to certain provisions of the "International Code of Zoological Nomenclature" is the ignoring of the principle of "once a homonym, always a homonym" applicable to all names rejected as secondary homonyms prior to 1960 (see Articles 59 and 60 of the Code). For example, see *Zoothera dauma major* on page 157. Ogawa named this form *Geocichla major* in 1905. In 1922, Hartert considered it a subspecies of *dauma*, and did not consider *Geocichla* separable from *Turdus*. He therefore renamed Ogawa's form *Turdus dauma amami*, as there was an earlier use of the name *major* within *Turdus*. Ogawa's name *major* was thus rejected as a secondary homonym long before 1960, so subsequent authors, no matter where they may place this form generically, are required by the Code to use the name *amami* Hartert for it. Now, it happens that neither Dr. Ripley nor I favor this provision of the Code. An unsuccessful attempt was made to overthrow it at the International Congress of Zoology in Washington in 1963, but it remains in force. I happen to believe that one cannot ethically be selective in adhering to a code of laws or rules. If we agree to abide by an "International Code of Zoological Nomenclature," we agree to all of it, not just the parts that do not clash

with our own preferences. The senior editor of this volume of the Check-list is a member of the International Commission on Zoological Nomenclature, so it seems somewhat surprising that such careful attention was paid to the provisions of Article 23b of the Code (relating to "nomina oblita" as in the *Microura* case), which are also unpopular with many taxonomists, while Article 59 was slighted.

Within the thrushes, I have the impression that some of the work of compilation may have been done hastily. There are several discrepancies within range descriptions, for example. On page 93 the range of *Myadestes leucogenys gularis* is given simply as "British Guiana," whereas it has been known from Venezuela for years, appearing in the standard literature (Phelps and Phelps, 1950. *Bol. Soc. Venez. Cien. Nat.*, 75:248). On page 216 the range of *Turdus l. leucomelas* as given omits Argentina; this form is found in Misiones (Olrog, 1959. "Las Aves Argentinas": 261). On page 150 *Zoothera naevia meruloides* is stated to breed in northwestern Montana, and in the same paragraph is called "casual in Montana." The latter phrase probably refers to winter status, but the punctuation of the paragraph makes it read otherwise. On page 113 two subspecies of *Saxicola caprata* are attributed to the island of Cebu (possibly because in my original description of *S. c. randi* I stated that I could not identify subspecifically the single Cebu specimen available). The new subspecific names proposed by Phillips (1962. *Anal. Inst. Biol. México*, 32 [1961]:351, 356) in the species *Catharus guttatus* are duly entered in synonymy (pages 173–174), but the subspecies recognized and the ranges given for them conform suspiciously closely to the treatment of the 1957 AOU Check-list. I do not believe Ripley could have given full consideration to some of Phillips' proposals, such as the synonymizing of *C. g. polionotus* with *auduboni*, with which I am thoroughly in accord after having examined specimens.

There is, in this volume, the inevitable sprinkling of typographical errors. I do not propose to list all of these that I have found, as some involve English words and will be apparent to any reader. In other cases, however, the error will be less obvious, and I have found from long experience that errors in standard references of this type tend to be perpetuated in later publications. Readers may wish to correct in their copies the following errors, typographical and otherwise.

Page 73, lines 18–20—the type locality restriction of *Cittocincla cebuensis* was made by Steere (1891. *Ibis*:314), not by Bourns and Worcester, 1894, as given.

Page 113, line 19—for Siguijor read Siquijor.

Page 136, line 3—for 1938 read 1838.

Page 166, lines 21 and 22—for Gines read Ginés.

Page 166, line 36—the spelling used by Zimmer was San Augustin.

Page 170, line 20—for **fuliginosa** read **fuliginosus**, to agree in gender with **Catharus**.

Page 194, line 28—for page 227 read page 277.

Page 210, line 28—for Tetaré read Tetarí.

Page 225, line 19—*rufopalliatus* was not hyphenated in van Rossem's original description of *grisior*.

Page 308, line 33—Salomonsen's paper, although dated "1961," did not appear until 1962.

Page 447, line 10—for Solimões read Solimões.

Page 447, line 27—for Baião read Baião.

Page 454, line 23—for *paraensis* read *paraënsis* (original spelling).

As has been my custom in these reviews, I present below for the convenience of any interested readers a summary of the differences (except those of sequence) between the taxonomic and nomenclatorial treatment in Volume 10 of the Check-list of Birds of the

World and that in the AOU Check-list. The present volume departs from AOU usage as follows:

1. *Prunella montanella* is considered monotypic, the race *badia* of the AOU Check-list not being recognized.
2. The family Turdidae is reduced to a subfamily of Muscicapidae.
3. The genus *Luscinia* is considered inseparable from *Erithacus*. Further, no races are recognized of the Ruby-throat, so *Luscinia calliope camtschatkensis* of the AOU Check-list is called simply *Erithacus calliope* by Ripley.
4. *Ixoreus*, the Varied Thrush, is considered inseparable from the Old World genus *Zoothera*.
5. *Hylocichla* is retained as a monotypic genus for the Wood Thrush only, the other four species being transferred to *Catharus*.
6. *Catharus fuscescens subpallidus* (Burleigh and Duvall), described since the AOU Check-list was published (1959. *Proc. Biol. Soc. Washington*, 72:33), is accepted.
7. Ripley follows the revision of Swainson's Thrush by G. Bond (1963. *Proc. U. S. Natl. Mus.*, 114:373–387), so that *incana* Godfrey is considered a synonym of the revived *almae* Oberholser, and *clarescens* Burleigh and Peters a synonym of *swainsoni* Tschudi; *Catharus ustulatus oedicus* (Oberholser) is revived as a valid race.
8. The name *musicus* having been placed on the "Official List of Rejected and Invalid Names in Zoology," the Red-wing becomes *Turdus iliacus*.
9. *Turdus confinis* is considered a subspecies of *T. migratorius*.
10. The wren-tits, *Chamaea*, are placed within the subfamily Timaliinae of the family Muscicapidae rather than as a separate family Chamaeidae.
11. The gnatcatchers are placed in a subfamily Polioptilinae of the Muscicapidae rather than as a subfamily of the Sylviidae.—Kenneth C. Parkes.

Birds of the New York Area. By John Bull. Harper & Row, New York, New York, 1964: 5½ × 8½ in., xiv + 540 pp., numerous line drawings and maps. $8.95.

Perhaps no area in the United States has been subjected to such constant and careful ornithological surveillance as the New York City region. As a result, no less than five studies on the subject have been published in the past seventy years. This long-awaited successor to Chapman ("Visitor's Guide to the Collection of Birds," 1894, and "The Birds of the Vicinity of New York City," 1906), Griscom ("Birds of the New York City Region," 1923), and Cruickshank ("Birds Around New York City," 1942) is the finest by far.

This is a monumental gathering and assimilation of information from a thousand sources, the earliest to the most recent (late 1962). The author set out not merely to update Cruickshank, but to go back to local beginnings and completely re-evaluate the data. In the course of five years of preparation, he examined over 20,000 specimens from almost every collection with birds from this area, discovering in the process many apparent errors and also many unpublished data of merit. In addition, he reviewed all the published data of the past, questioning many long-accepted records; to this he has added the sizable accumulation of the last twenty years. It is all here, weighed and sorted out into useful analytical information that will be a mandatory reference work for students for the next generation, a lasting historical record, and, it is hoped, a tremendous spur to further investigation of the many unsolved problems that are so ably revealed.

The major part of the book (415 pages) is devoted to the detailed species accounts—

the annotated list. But useful introductory chapters include a history (with emphasis on local collections), a brief guide to local bird-watching sites, a summary of ornithological trends since 1942, a discussion of breeding species, local migration, qualitative standards (the acceptance of records) and quantitative data (standards of abundance and frequency), an excellent summary of the effects of recent hurricanes, and a brief discussion of subspecies. Appended are a glossary, a 17-page bibliography, a gazetteer, and an index.

The species accounts are organized under the headings of "Range" (specieswide), "Status" (local), "Change in status," "Migration," "Occurrence and maxima" (including discussion of breeding when present), and "Remarks." Headings are not inviolate; accidental and introduced species are handled somewhat differently, but in every case the information is easily available. Treatments vary in length according to need: the single record of the Eurasian Curlew takes just four lines; the history of the recently introduced House Finch, five pages. For many species of changing status the treatment is a historical summary, often with breeding-site maps and tables showing population changes.

Bull has aimed his book at a more sophisticated audience than his forerunners, and whenever there are interesting problems of taxonomy, identification, distribution, or population, a thorough discussion is presented, often brilliantly. Thus three pages are devoted to the fascinating Traill's Flycatcher complex, and an equal space to the hybrid warblers.

"Birds of the New York Area" is not without its faults, but they do little to detract from the over-all merit of the work. The title itself seems less than perfect, since there is a state, city, and county named New York. In his introduction, Bull re-defines a number of ornithological terms without really improving the situation. In the bird-watching guide, several excellent areas, such as Fire Island, Hecksher Park–Carman's River, and most of Westchester County are omitted. In the chapter on breeding birds, the author changes the traditional faunal zone names of Canadian, Transition, and Carolinian to Northern, Neutral, and Southern, all three of which are the kind of meaningless comparatives he himself decries in the name "Common" Egret. (Actually *Transition* is exactly the right word for a region of overlap.)

Bull has departed from the 1957 AOU Check-list by altering the sequence in the case of the teal-shoveler complex and the phalaropes, by changing the vernacular names of four species (Common Egret to Great Egret, Common Teal to Eurasian Teal, Common Scoter to Black Scoter, and Wood Ibis to Wood Stork), and by altering three scientific names. Apparently unintentional is the switching of sequence of the two local bitterns, of the Ruff and Sanderling, and of the Gray Partridge and Ring-necked Pheasant.

It is in the species treatments that the author will probably be most criticized, for many local observers will unfortunately judge the book on the number of their own prized records that are missing. Bull has set rigid standards of admissibility, and the requirement of three able observers per sight record has doubtless ruled out some valid records. Unfortunately, he does not always maintain his own criteria; certain favored experts seem to have a blanket cachet while others have been roughly handled.

As for specific disagreements, every conversant reader will find his own. My copy has notations inserted at more than 80 places thus far. Some of them read, "Location in pond no reason to reject Barrow's Goldeneye record; often found in small ponds in West." "Why not more discussion of status and identification of scaups?" "Ruffed Grouse status not very edifying." "Whip-poor-will distribution seems vague." "Estimate of one million Herring Gulls wintering probably 5 times actual total. Recent combined Christmas count was 125,000." "Why not data on annual waterfowl count for area, first taken 1939 and full of interesting comparative data?" "Rye Purple Martin colony to 1941 only. It is

still extant." "Why not much more banding data?" But these are minor questions against a major and important success.

The book is typographically excellent. I noted a few minor errors, including the misspelling of *Puffinus diomedea* (page 77). The drawings of Cornelius Ward (except for a strange Oystercatcher) are decorative, and the end-paper map and breeding distribution maps of Richard Edes Harrison are clear and accurate.

One rather disappointing feature of the book is the forward by Roger Tory Peterson, in which once again the fame of the Bronx County Bird Club is expounded. According to Peterson, this book, like its two immediate predecessors, is a direct product of that briefly active, now defunct coterie. The truth is that while several members of the group did go on to fame and fortune, the group had nothing to do with either Griscom's or Cruickshank's book, and Bull was never even a member. Conversely, the organization that Peterson should credit is the Linnaean Society of New York where the group actually sat and learned with the old masters. The two books mentioned above credit the Linnaean Society on their title pages, as should the present work, for without the endorsement, aid, advice, encouragement, editing, and cooperation of the Linnaean Society and many of its members, Bull would never have written his book at all. The fact that nowhere does he or Peterson acknowledge it is lamentable.—Robert S. Arbib, Jr.

A Distributional Study of the Birds of British Honduras. By Stephen M. Russell. American Ornithologists' Union, Ornithological Monographs No. 1, 1964: 195 pp., 2 col. pls., 16 photos, 1 map. $4.50 ($3.60 to members of the A.O.U.).

This is an important publication as it represents the first comprehensive account of the birds of British Honduras and the first of a new monograph series sponsored by the American Ornithologists' Union. The book covers investigations by the author from 1954 through 1963, including data gathered during a total of 13 months in the field over an eight-year period. These studies were also the subject of Dr. Russell's Ph.D. dissertation, a fact of which their thoroughness is indicative.

"British Honduras [or Belize, as it is called by most Spanish-speaking Central Americans] is a Crown Colony of about 8,600 square miles situated at the southern base of the Yucatan Peninsula. . . . It is bounded on the north by Mexico, on the west and south by Guatemala, and on the east by the Caribbean Sea. It includes numerous small keys. Tall tropical forests predominate on the mainland, which is relatively low. . . . The only mountainous area has maximum elevations of 3,700 feet. . . . Mangroves, wet savannas . . ., pinelands, and 'rain forests' are the principal vegetational formations. . . ." It is surprising that this small, English-speaking, accessible tropical country has not previously been the subject of a comprehensive report. W. E. C. Todd and (later) J. Van Tyne had such a project in mind and amassed collections from the colony, but their diverse interests prevented completion of the work. Other well-known ornithologists and collectors have worked in British Honduras and published on their material, but it remained for Russell to assemble all the previous data and supplement these by his own efforts to produce the present volume.

The book is virtually a model of compact organization and thoroughness in a distributional study. An introductory section includes a resumé of all ornithological investigations in British Honduras, a complete, detailed gazetteer of localities, a map showing 93 of the most important of these, and a brief summary of the topography, geology, climate, and vegetation. The life-zone system of Holdridge (1947. *Science*, 105:367–368) is followed except that "rain forest" is used in accordance with popular rather than special

(annual rainfall > 8,000 mm) usage, and there are 16 habitat photographs. The species accounts, 465 in all, occupy pages 32 to 185. As these constitute the bulk of the work, their plan is worth comment. A family heading is included. Each account is introduced by the scientific binomen (those not documented by a specimen are in brackets) followed by an English vernacular name. The latter corresponds to that used in the fifth edition of the AOU Check-list if the species is included in it; otherwise, Eisenmann (1955. *Trans. Linn. Soc. N.Y.*, 7:vi + 128 pp.) is usually followed. Summarized information (locality, sex, date, and weight in grams) is given for all specimens collected by the author and his associates and deposited in the Louisiana State University Museum of Zoology. For specimens in other museums, locality and month are the only data given; a "Critical Published Record" is cited for specimens recorded in the literature from additional localities. The annotations include summaries of the birds' distribution and seasonal occurrence within British Honduras, the major habitat preferences, data on reproductive season, estimates of relative abundance, and comments on natural history if these are supplementary or contradictory to previously published information. The subspecies as determined by the author is given for each polytypic species, accompanied by a discussion when pertinent. Following the species accounts there is a brief (5 pages) "Discussion and Conclusions" section and a complete bibliography. There is no index. Two fine color plates by Eckelberry—the Ocellated Turkey (frontispiece) and three grassland-inhabiting passerines—are included.

The relatively slight variety in topography and habitat in this small area does not support a highly distinctive or much-differentiated avifauna. The discussion section calls attention to those forms whose affinities seem to be with populations occupying the drier parts of the Yucatán peninsula, the Caribbean slope "rain" forest, and the montane forests of Central America, or the West Indies. Among the colony's habitats, only the pine ridges and lowland pine savannas are isolated to any important degree from other similar regions. There are very few endemic forms, only rarely does more than one subspecies of a given species occur within the borders of the colony, and very few forms reach the limits of their range there. This situation is not one to encourage sweeping zoogeographic generalizations, and the author has limited his discussions accordingly.

In a distributional work that packs so much information into a small amount of space, one finds little to criticize except relatively trivial matters. A few of the habitat photographs are not very clear; neither is the exact meaning and use of "Critical Published Record" in the species accounts. I would have preferred more of the vernacular names proposed by Eisenmann (op. cit.) and fewer of those drawn from Ridgway or Hellmayr. An editorial criticism is that space is used unnecessarily in the bibliography by including a complete and separate listing for each cited volume of Ridgway, Hellmayr, Peters, etc.—surely a more economical way of referring to series publications could be devised.

In summary, this is a very careful and thorough account of the avifauna of a relatively neglected portion of Central America, and its usefulness extends considerably beyond the borders of the area with which it deals. Both author and publisher are to be congratulated on a fine first effort.—Thomas R. Howell.

A Field Guide to the Birds of East and Central Africa. By John G. Williams. Houghton Mifflin Company, Boston, 1964: 5¼ × 7¾ in., 288 pp. incl. 1 map, 44 pls. (16 col., 24 bl. and wh.). $6.00. (Except for a different title page and differently colored dust jacket and binding, this edition is identical to the 1963 Collins edition printed in Great Britain.)

Anyone who has worked in eastern Africa, weighed down by the two hefty volumes of Mackworth-Praed and Grant ("African Handbook of Birds," Series I) and/or the three larger classics of Jackson and Sclater ("Birds of Kenya Colony and the Uganda Protectorate"), can appreciate the need of a field guide to the avifauna of this exciting part of the world. Mr. Williams' "Guide" is a very welcome addition to the safari paraphernalia of anyone interested in birds. It will slip readily into the pocket of a bush jacket (but not in one's hip pocket; it is bigger in all dimensions than our Peterson "Field Guides").

In 1963, I had a bound copy of the page proofs of the text available to me in the field. It was evident that had such a volume been available on my first trip to East Africa two years earlier the business of identifying birds would have been very much easier. At that time, although I had devoted several months of concentrated effort to the study of all available literature pertaining to identification, I found myself puzzled by not a few species when I first saw them alive. My great reliance on Mackworth-Praed and Grant with their abundant (but sometimes misleading) colored plates had failed to prepare me adequately. Although these plates depicted a great many species, they failed to illustrate a number of the *common* birds which the visiting bird student is almost certain to encounter—the Striped Kingfisher (*Halcyon chelicuti*), Klaas' Cuckoo (*Chrysococcyx klaas*), Bearded Woodpecker (*Thripias namaquus*), Common Puff-back (*Dryoscopus cubla*), White-breasted Tit (*Parus albiventris*), Red-collared Widow-bird (*Coliuspasser ardens*), Bronze Manakin (*Spermestes cucullatus*), and doubtless others. Perhaps the chief benefit of the Williams Guide to serious bird students visiting Africa for the first time is in having the readily seen species treated in detail and illustrated, for these serve as points of comparison for the many other forms dealt with by Mackworth-Praed and Grant. The latter volumes, incidentally, will remain indispensable, for the scope of the Williams book is limited. It treats about 780 species, only 459 of which are accorded separate accounts; the remainder are very briefly discussed under included paragraphs dealing with "allied species." (Mackworth-Praed and Grant, by comparison, devote over 1,900 pages to all 1,487 species recorded from eastern Africa.) This, the most obvious shortcoming of the book, is pointed out by the author himself in the preface. A complete one-volume work on the birds from southern Mozambique to Eritrea would be no "field guide" to fit in one's pocket. Even for Kenya alone, with over 1,030 full species, a single Peterson-type volume would be impractical. The author's original plan (which we hope will be followed to completion) was to produce this initial guide to the species most likely to be seen by the bird-watcher, and a second, companion, volume treating the less common and more secretive birds.

With a single book treating only certain species, one would, of course, be liable to misidentify some birds. For example, a user of the present volume in Kenya or Uganda, with no other source of information available, would be forced to consider any black-headed oriole as *Oriolus larvatus*. However, there are places there where one would see only *Oriolus brachyrhynchus*, and another species, *O. nigripennis*, could be found in still other areas. Distinguishing these three orioles high in the forest trees is not always easy. In fairness, it must be stressed that nine out of ten binocular-wielding visitors to the usual East African tourist areas will see only *Oriolus larvatus* and not the other two. Nevertheless, I think it unfortunate that these species could not at least have been mentioned by name so that an observer would be aware of other possibilities.

A typical species account begins, under the heading "Identification," with an average measurement in inches, a brief description including major field marks and useful comments on habitat, abundance, gregariousness, etc., particularly helpful because each bird is compared with certain other similar species in these respects. Also, there are frequent

references to unusual or distinetive behavior sueh as the wing-flieking of the Olive Sunbird or the noeturnal habits of the Violet-tipped Courser. Following Identification is a line or two on "Voice" and a statement on "Distribution and Habitat." The speeies account is terminated by an often lengthy "Allied Species" seetion where eertain related species are discussed in varying detail. This is most useful, and is a unique feature in books dealing with East Afriean birds. However, there is one diffieulty. The "allied" specics diseussed in a given speeies aeeount are not neeessarily *similar* speeies insofar as the field observer is concerned. The Red-breasted Wryneek, *Jynx ruficollis*, for example, is diseussed only under the Gray Woodpeeker where it is unlikely to be found (save through a chanee encounter) by the neophyte who is unaware that the peeuliar-looking creature he's watehing is a member of the Picidae. As with any field guide, of eourse, optimum usefulness is dependent upon the user's degree of familiarity with the book. Particularly with as rich an avifauna as that in tropical Africa, a prospective observer should read and reread the entire book, and carefully study its illustrations, before setting foot on Afriean soil.

This volume adheres rather elosely to the pattern of the Peterson Field Guide series of which it is a part. There is an introduetion by Roger Peterson, a table of contents, list of illustrations, and a seetion on how to use the book. These, together with the prefaee, an adequate map showing all areas eovered, and a good bird topography drawing, occupy the first 18 pages.

The illustrations are far more polished than those in some recent field guides to tropical birds, although I personally found them rather disappointing—particularly after having been so favorably impressed by the originals of some of the eolor plates which I saw in Nairobi a few ycars ago. These seem to have suffered in reproduction. The pictures in my two copies lack the richness and depth of eolor I remember in the originals; the figurcs are sometimes pale and not very realistie. The title page of the book states that the plates are "by the author and Mrs. R. Fennessy" but I have not been able to determine what the latter's role may have been in their preparation.

The blaek-and-white plates are less sueeessful than those in eolor, and some passerines would be extremely diffieult to identify from the figures alone (as, for example, the Silverbird and Fischer's Greenbul on Plate 29). The proportions of some figures seem incorrect, particularly in head and bill sizc. On Plate 29 the Yellow-vented Bulbul is depicted as larger than the Arrow-marked Babbler; aetually the babbler averages nearly two inches longer.

Tighter arrangements of the figures and utilization of waste spaee could have resulted in one or two more speeies being illustrated on certain plates. However, the figures are large (an improvement over many plates in Maekworth-Praed and Grant) and the plates themselves uncluttered. In general, the illustrations are entirely satisfaetory.

More careful editing would have helped in numerous plaees. There is some unneeessary repetition in the "Allied Speeies" sections of material presented just above it in the species descriptions (see the Cattle Egret and Mountain Buzzard aeeounts for examples). With more severe editing, resulting in condensation of the material, several additional species might have been included within the present number of pages. There is an odd and inconsistent use of the colon on many pages, this mark appearing where a semicolon would normally be used. Jaçana is spelled throughout without the cedilla. It is unfortunate that the plate headings were not more carefully eheeked. Among the conspieuous mistakes which should have been eaught in editing (and whieh appear in both the 1963 British and 1964 Ameriean editions) are: "White-faced" instead of White-eyed Kestrel on page 61; the referenee, opposite Plate 40, to page 274 for the Pin-tailed Whydah

account (which is on page 267); a similar erroneous reference opposite Plate 29 to page 18 for discussion of *Pycnonotus tricolor* (actually on page 192); transpositions of both captions and numbers for the Yellow Bishop and White-winged Widow-bird on Plate 39; an apostrophe in "Barbets" in the heading of Plate 24; and this same caption reappearing (without the apostrophe) in the midst of the caprimulgid text on page 156.

There are few typographical errors and the single factual error I find is of little importance. (The Yellow-whiskered Greenbul is said to be "always" identifiable by its yellow moustachial streaks. Full-tailed juveniles, however, lack these and can mislead an observer not familiar with the confusing array of African greenbuls.)

There are few departures from either the technical or vernacular nomenclature employed by Mackworth-Praed and Grant, and this will aid persons already used to the latter. I noted the following changes in the Williams Guide. The Dusky Nightjar (*Caprimulgus fraenatus*) is considered specifically distinct from the extralimital *C. pectoralis*. *Anthus richardi* is resurrected for Richard's Pipit, the author evidently (like this reviewer) being sceptical about this familiar African bird representing *A. novae seelandiae* of New Zealand. The genus of paradise-flycatchers is *Terpsiphone* (rather than *Tchitrea*). The Ground-scraper Thrush, *Psophocichla litsipsirupa* of Mackworth-Praed and Grant, is placed in *Turdus*. *Oenanthe lugubris* is called Schalow's Wheatear (after the race *schalowi*) whereas Mackworth-Praed and Grant treat it under the species name Abyssinian Black Wheatear. *Anthreptes orientalis*, the Kenya Violet-backed Sunbird, is here considered specifically distinct from *A. longuemarei*. (The Uluguru Violet-back, *A. neglectus*, is not treated in the Field Guide.) *Coliuspasser ardens*, the Red-collared Widow-bird, includes *C. laticauda* (the "Red-naped Widow-bird" of Mackworth-Praed and Grant), as well as the all-black form *concolor*, conforming with general current usage. The various yellow-vented and white-vented bulbuls (*Pycnonotus xanthopygos*, *P. dodsoni*, *P. barbatus*, and *P. tricolor* of Mackworth-Praed and Grant) are treated as conspecific under the name *Pycnonotus xanthopygos*, Dark-capped Bulbul. But if all four are to be united they should, I believe, be called *P. barbatus* (based on *Turdus barbatus* Desf. 1789; cf. Sclater, 1930. *Syst. Avium Aethiop.* II, 372). They are so considered by White's 1962 "Revised Check List of African Shrikes . . . Bulbuls . . . and Babblers." *Turdus abyssinicus* and *T. olivaceus* are considered together under the latter name (as in Mackworth-Praed and Grant) despite the treatment in Chapin (1953. *Bull. Am. Mus. Nat. Hist.*, 75A), and White (op. cit.).

American users of the Guide will of course notice certain differences in family limits and family names compared with the familiar Wetmore arrangement followed by most American works. The grebes are termed Podicipidae (instead of Podicipedidae). The vultures, under Aegypiidae, are segregated from all other falconiformes (buzzards, falcons, accipiters, and osprey) which are placed in the Falconidae. Phasianidae includes the guinea fowls (Numididae), as in Mackworth-Praed and Grant. The crane family is called Balearicidae, not Gruidae; and that of the babblers Turdoididae (instead of Timaliidae). The buntings, Emberizidae, are kept distinct from the Fringillidae. Muscicapidae is reserved for the flycatchers, with the thrushes and warblers each accorded family status.

The Avocet and Black-winged Stilt are listed among the Charadriidae (as are references to the Oystercatcher and Crab Plover, but this may not imply any intentional broad lumping as these are treated only in the "Allied Species" sections). Rostratulidae is maintained for the Painted-snipe.

Owing to the numerous deviations from the Wetmore classification many readers will appreciate the adequate index. The sequence of families, like that in Mackworth-Praed and Grant, will be somewhat confusing to American readers. It takes time to learn that

the coraciiform families precede the owls, nightjars, and trogons; and that the swifts appear between the woodpeckers and the Passeriformes. And it will be no easier within the latter order where swallows come after the warblers, pipits follow the larks, and various other groups seem, to us, peculiarly disposed.

I have written this review primarily for those who have not yet enjoyed bird study in East Africa, but this book will benefit many who have already visited the region. One can learn from it many things not expected in a field guide—for example, that crabs constitute the main diet of the Giant Kingfisher, or that *Tmetothylacus*, the Golden Pipit, "is remarkable among the passerine birds in having the lower third of the tibia bare, as if it were a wading bird [and not in fact] an arid bush country species." (Unless one is collecting, or has read about *Tmetothylacus* in "Jackson" he might remain unaware of this. Mackworth-Praed and Grant do not mention it.) Such inclusions may be no contribution to field identification, but they certainly add to the interest of the book.

It is easy to criticize an author for not including certain species, but no two persons would select exactly the same birds from a list of over 1,000 possibilities. I was somewhat surprised not to find any mention of *Prinia leucopogon*, *Apalis cinerea*, and *Cisticola hunteri*—all rather common or conspicuous species—but many exclusions were necessary under the proposed two-volume plan. The author has done an admirable job of selecting the forms most likely to be seen by the greatest number of persons—residents and tourists alike. There might appear to be excessive emphasis on those forms likely to be encountered in the Kenya highlands, at Amboseli and the Tsavo Park, or about Mombasa and Entebbe, but these are the areas visited by most foreign travelers and the species included are entirely appropriate for this book's intended audience. Mr. Williams has drawn on a long and intimate association with African birds to include precisely those comments on behavior, habitat preferences, and similar matters other than straight morphological description, that produce a truly useful and authoritative field guide. It should materially aid in stimulating interest in African birds.—Dale A. Zimmerman.

The World of the Red-tailed Hawk. By G. Ronald Austing. Living World Book Series, John Terres, Editor. J. B. Lippincott Co., Philadelphia and New York, 1964: 7¾ × 10⅜ in., 128 pp., 89 photos. $4.95.

Austing's "World of the Red-tailed Hawk" is an extremely attractive book dealing popularly with one of North America's best known, most conspicuous, and wide-ranging hawks. It tells a highly sympathetic story of what has for so many years been widely referred to as the "Big Chicken Hawk"—a title highly undeserved, as the author points out. The Red-tail's world is a vigorous, competitive, cruel, and often gory world but for contrast the author points out the devotion of mated birds to each other and the gentle care taken of the tiny downy young. Mr. Austing sees, accepts, and thrills to this whole panorama and, as many naturalists do today, genuinely regrets to see the juggernaut of "Modern Man" rolling inexorably over the natural habitat, threatening to gradually eliminate the Red-tail from the American scene. With him we hope our conservation efforts will preserve large enough segments of forested America to retain such a striking bird in our fauna for at least a few more generations.

This is a book largely of personal experiences with ideas and suggestions based on the author's extensive field-acquired knowledge of the Red-tail's habits. It is not a compilation of factual data gleaned from a thorough search of the literature—it is not a compendium of tables on food studies of Red-tails or a critical examination of the manner in which Red-tail behavior varies from Florida to Alaska. Perhaps such broad coverage might

justifiably be expected from the rather comprehensive title given the book. However, I feel that the idea of the "world" of this bird is well carried out by the understanding way the author has attempted to present the hawk's life habits and requirements, not technically as an autobiography but sympathetically from the standpoint of the bird itself. The reader gets the feeling of knowing something of the thoughts and attitudes of an Ohio Red-tail as he looks over his domain from the top of some dead snag among the hills along the Whitewater River.

The format of the book is attractive and the 89 excellent photographs of not only the life history of the Red-tail itself, but of its prey, its habitat, its associates, and its enemies augment the text admirably. The reference list of only 12 titles includes some rather specialized articles and could have been expanded easily to include better general reading suggestions for the uninitiated. One is a bit surprised to find on page 91 a reference to a "Whippoorwill" found hibernating in California when the species concerned was the Poor-will. And Minnesotans will be a little disappointed not to find the Duluth hawk-pass referred to among the well-known concentration points of migrating hawks. In spite of these minor criticisms and the fact that the "world" is geographically somewhat limited, this book succeeds in giving the reader a vital, sympathetic view of this fine American predator.—W. J. Breckenridge.

This issue of *The Wilson Bulletin* was published on 1 April 1965.

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Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subsequently identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on gloss paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the printer of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated in the mailing list and there is a printer's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

Notice of Change of Address

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadephia 3, Pennsylvania. He will notify the printer.

PLAN TO ATTEND THE 1965 ANNUAL MEETING

The 1965 meeting of The Wilson Ornithological Society will be held from Thursday to Sunday, 17 through 20 June 1965 at Sylvan Lake Lodge, in the Black Hills of South Dakota. Sponsoring organizations are the Black Hills Audubon Society and The South Dakota Ornithologists' Union. Dr. N. R. Whitney, Jr., 633 South Berry Pines Road, Rapid City, South Dakota, is chairman of the local committee for arrangements.

The meeting will open Thursday evening with a reception and an informal program of slides on South Dakota birdlife. The paper sessions will be held on Friday and Saturday with early morning field trips Friday and Saturday mornings in the vicinity of Sylvan Lake, to observe the breeding birds of the forests of ponderosa pine and Black Hills spruce. The field trip Sunday will visit Spearfish Canyon in the northern Black Hills, an outstanding area for White-throated Swifts, Violet-green Swallows, and Dippers. Outstanding areas within hiking distance of Sylvan Lake include Harney Peak and the Needles, and within short driving distance are Mount Rushmore National Memorial, Wind Cave National Park, and Jewel Cave National Monument. At least twenty species of western birds reach the eastern extremity of their range in the Black Hills or in the adjacent plains and at least ten northern species are on the southern edge of their breeding range in the spruce forests of the Black Hills. In addition, the Black Hills are the home of the White-winged Junco, which can usually be found nesting in the immediate vicinity of Sylvan Lake.

The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 77, No. 2, JUNE 1965 · PAGES 109-214

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THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be ordered from the Treasurer. Special prices will be quoted for quantity orders.

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Second class postage paid at Lawrence, Kansas, U.S.A. Additional entry at Ann Arbor, Mich.

PRINTED IN U.S.A. The Allen Press, Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Society

VOL. 77, NO. 2 JUNE 1965 Pages 109–214

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Pyrrhura frontalis
Watercolor by Don R. Ekelberry
Tobunas, Misiones, Argentina,
Sept. 6, 1959

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A NOTE ON THE PARROTS OF NORTHEASTERN ARGENTINA

Don R. Eckelberry

Of the 25 species of parrots known to occur in Argentina, more than half inhabit the humid tropical northeastern province of Misiones. Some of these are shared, usually in the form of a distinct race, with the wet tropical spur descending from the north along the eastern base of the Andes as far as Tucuman.

In the immediate vicinity of Iguassú Falls at the Brazilian border I have seen six species representing a like number of genera in the course of a day's field work: *Aratinga leucophthalmus, Forpus passerinus, Pionus maximiliani, Amazona vinacea, Ara maracana, and Pyrrhura frontalis.* Another genus and species, *Pionopsitta pileata,* was regularly seen at our camp near Tobunas to the south where, of the Iguassú species, *Aratinga* and *Forpus* were not observed.

Throughout Misiones the Red-bellied Parakeet (*Pyrrhura frontalis*) appeared to be the most common and least shy psittacid. The bird pictured opposite was collected and painted on 6 September 1959. At rest or in flight they are much like Aratingas, moving about in small, noisy flocks at high speed.

The flight of the small macaw, *Ara maracana,* was unlike that of any other member of the genus I have seen, including similarly sized species in Trinidad and Surinam. They pitched up in flight, not in the undulatory manner of woodpeckers, but in a peculiarly jerky, rearing motion. As they traveled in pairs I thought at first that this might be a courtship performance, but at no time did I see them in the direct flight typical of macaws.

It might be appropriate here to suggest that future field guides to neotropical birds should point out that the similarly proportioned *Amazona* and *Pionus* parrots can be separated at any distance in flight by the depth of the wing stroke. That of *Amazona* is very shallow, while the primaries of *Pionus* are almost straight down at the end of the stroke.

180 Woodsome Road, Babylon, New York. 30 April 1965

THE DISPLAYS OF THE AMERICAN GREEN-WINGED TEAL

F. McKinney

The displays of the European race of the Green-winged Teal (*Anas crecca crecca*) have been studied intensively (Lorenz, 1953, 1958; Lorenz and von de Wall, 1960; von de Wall, 1963) but no detailed description has been published for the North American race (*A. c. carolinensis*). Some displays of *carolinensis* have been described (e.g., Sutton, *in* Bent, 1923; Johnsgard, 1955), but in general it has been assumed that the behavior of the two races is identical (e.g., Phillips, 1923; Parkes, 1958). An inventory of *carolinensis* displays is presented here as a basis for intensive studies of pair-formation in this race now in progress. This account is based on observations of both wild and captive birds made at Delta, Manitoba between 1955 and 1963, and analysis of 800 feet of movie film.

The Green-winged Teal has a highly developed "social courtship" ("Gesellschaftsspiel," Heinroth, 1910) in which a number of males swim around a female giving display movements and whistling loudly. As Lorenz has described, many of the behavior patterns have homologues in the Mallard (*Anas platyrhynchos*) but all movements are faster. This paper deals primarily with the displays associated with social courtship and the process of pair-formation. In most cases I have used the names for displays coined by Lorenz.

DISPLAYS OF THE MALE

Burp.—("Krick" Whistle, Lorenz, 1953; "Aufstossen" (Burping), von de Wall, 1963). The head is raised vertically as a loud, liquid *tlu* call is uttered. The feathers of the crown are raised and the "mane" on the nape is conspicuous. As the call is given, the feathers of the back and wings are momentarily vibrated, giving the effect of a shuddering motion. Several Burps are often given in succession, the head being raised slightly each time.

In *crecca*, Lorenz (1953) noted that this call is given "in fear when a person is coming near their pen" and he believed that it "combines the functions of call-note and warning." It also occurs frequently as an introduction to social courtship (von de Wall, 1963). In *carolinensis*, the Burp occurs in the same situations. In captives, it became regular as a response to a mild disturbance in March. At times it is given by a paired male when his female is some distance away, and I have seen her apparently respond to the call by returning to him.

Grunt-whistle.—This display is performed when the male is broadside to the female, but not very close to her (usually 4 to 6 feet away). One or two rapid Head-shakes precede the display.

The Grunt-whistle consists of a brief rearing up on the water with the head

bent forward in an arc. At the peak of the movement the bill is very rapidly shaken in the water, causing a fine stream of water drops to be thrown up in the air on the side toward the female (Fig. 1). A single, loud, liquid *tliu* followed by a quiet grunting sound accompany the movement. Fast, quiet, cheeping noises, similar to those accompanying Bill-up (see below), have been heard during the preceding Head-shakes.

The Grunt-whistle is usually followed immediately by a Head-flick and a simultaneous Tail-wag, then Head-up-tail-up and Turn-toward-female may be performed. The latter two displays were recorded after forty-five of seventy-three Grunt-whistles.

Head-up-tail-up (HUTU) and *Turn-toward-female* (TTF).—These two displays are almost invariably linked together. In forty-eight sequences, TTF was omitted only once; in another instance, a male performed TTF without the preceding Grunt-whistle and HUTU.

The typical sequence occurs immediately after the Head-flick and Tail-wag which follow the Grunt-whistle. Twice I recorded two HUTU + TTF sequences separated only by Nod-swimming.

Like the Grunt-whistle, HUTU is performed with the long axis of the male's body lateral to the female. Suddenly the tail is cocked, the wing-tips rise about 45°, and the head is moved back and upward slightly, the bill resting on the chest. As the wings and tail are dropping back to a normal position the bird executes a rapid right-angle turn to face the female, the head remains in an erect and somewhat backward position and a single clear whistle is given (Fig. 2). This call is not so loud as that accompanying the Grunt-whistle.

Bill-up.—("Chin-lifting," Lorenz, 1953). The head is tucked deep "in the shoulders," the bill points up to a varying extent (at times perhaps as much as 45° from the horizontal), and chittering notes are given (Fig. 3). Very rapid lateral Head-shakes are often performed from the Bill-up posture.

The degree of up-tilting of the bill and the characteristics of the calls are variable. Bill-up is closely associated with overt hostility between males and the intensity of the display appears to be correlated with the proximity of the birds in question. The speed and pitch of the chittering increase until the quality of the noise changes to a series of very rapid whistles *pepepepepepe* . . . as the distance between the two birds decreases.

Down-up.—As von de Wall has noted in *crecca*, Down-up is preceded and followed by Bill-up, both displays occurring especially when hostile males approach one another closely. The tail and rear end of the body are suddenly raised high in the air and at once lowered again (Fig. 4). The movement is accompanied by a series of three rapid whistles.

Nod-swimming.—This is not highly ritualized as it is in the Mallard; the head is merely moved forward and back, with varying degrees of intensity, as

FIG. 1. Grunt-whistle.

FIG. 2. Turn-toward-female. The tail and wings are being returned to their usual positions after the Head-up-tail-up.

FIG. 3. Bill-up by male on left and male in right foreground.

FIG. 4. Two males perform Down-up. The bird on the left is close to the peak position, the one on the right is past the peak.

FIG. 5. A male performs Turn-back-of-head as the female swims toward him.

FIG. 6. Bridling.

FIG. 7. Male gives Bill-dip while standing stiffly with his body in a deliberately lateral position to the female. The female is paired to this male as shown by the threatening component of Inciting which is being directed toward another nearby male.

FIG. 8. Male performs ritualized Preen-behind-wing.

the bird swims. Jerky swimming movements of this type are often performed as a male in a courting group maneuvers, avoiding other males and apparently trying to get into a favorable position to perform a display oriented at the female. The duration of a bout of Nod-swimming is variable and the activity appears to "punctuate" a period of social courtship, bridging many of the gaps between Shakes, Grunt-whistles, etc.

Turn-back-of-head.—The male swims in front of the female holding his head in such a position that the nape is directed at the female (Fig. 5). Often this display follows the Grunt-whistle + HUTU + TTF sequence but it can also occur independently.

Bridling.—This display is performed on land, although the female to which the male aligns himself laterally may be swimming nearby. First a Shake is given and, during the Tail-wag which regularly follows, the head is moved backward quite slowly, the chest protruding forward, and while in this posture a single whistle is given (Fig. 6). The long axis of the head is slightly off center, the head being moved to the side farthest from the female.

I can find no record of the postcopulatory display of *carolinensis* and I have not seen it. In *crecca*, the male gives a single Bridling movement (von de Wall, 1963; personal observation).

Shake.—Males perform body-shakes, both on land and while swimming, in a position lateral to the female. Some Shakes are isolated, but many immediately precede other displays, notably Drink, Bridling, and Belly-preen. These Shakes are similar to normal comfort movements, but sometimes they appear to be slightly exaggerated.

The term "Introductory Shaking" (Lorenz, 1953) is not entirely appropriate for this species. Shakes can occur at the beginning of a period of social courtship but they also occur at other times in the bout.

Head-shake.—Rapid lateral Head-shakes are given singly and they are also linked to certain other displays (see Grunt-whistle, Bill-up).

Head-flick.—This rapid head movement, involving a rotary component, occurs independently and also in association with the Grunt-whistle and Wing-flap.

Bill-dip.—The bill is briefly dipped in the water (Fig. 7). This movement does not appear to be rigidly linked with other displays, but several times it was noted in association with Preen displays.

Drink.—Drink is given as the male swims or stands at the edge of the water, his body being deliberately turned broadside to the female. The movement is similar to normal drinking but perhaps the up-tilting of the head is slightly exaggerated.

Sometimes Drink is immediately preceded or followed by another display. The following associations were noted (number of records in parentheses):

preceded by Down-up (1), Head-flick (1), Wing-flap + Head-flick (1), Belly-preen (2), Shake on land (4); followed by Preen-dorsally (3), Preen-behind-wing (1), Shake on land (1).

Preening.—Three preening movements appear to be ritualized: Preen-dorsally, Belly-preen, and Preen-behind-wing (Fig. 8). These are all performed as the male stands or swims with his body lateral to the female. Preen-dorsally is common in swimming birds but Belly-preen is given only on land. Belly-preen is usually preceded by a Shake; sometimes the preening movement is repeated rapidly a number of times, the bill touching the belly each time.

Nonritualized preening movements on other parts of the body may follow Preen displays and it is often difficult to distinguish between the two types.

Wing-flap.—This is also given with lateral orientation to the female but it does not differ strikingly in form from the normal comfort movement.

Jump-flight.—In social courtship groups, males perform short flights a few yards in length. Some are similar to the Jump-flights of the Mallard and Shoveler (*Anas clypeata*) but, as Lebret (1958) noted in *crecca*, they are less obviously ritualized. Other flights seem to be merely avoidance responses resulting from a chase by another male.

Multi-syllabled Whistles.—These are heard constantly from males in social courtship groups. The calls associated with the Burp, Grunt-whistle, Head-up-tail-up, Down-up, and Bridling add to the chorus. A variety of calls (generally 3- or 4-syllabled, e.g., *te tiu te, te tiu tu tete*) are given without accompanying body movements and the bill is not opened conspicuously as it is during display movements (e.g., Fig. 2).

Pre-copulatory Pumping.—Pre-copulatory Pumping, involving vertical movements of the head, is similar to that of the Mallard and many other species of *Anas*. Many times I have seen these movements performed by both members of a pair but mounting has not followed.

DISPLAYS OF THE FEMALE

Inciting.—Inciting is similar to that of the Mallard, involving highly ritualized, sideways threatening movements (Fig. 7). After each pointing movement, as the head is moved back toward the body, a rapid, harsh, rattling call is given, higher-pitched than in the Mallard. As in other ducks, this display shows (to the observer and presumably to all males present) the female's attachment to one male and her rejection of another. Its performance is usually an indication that a pair-bond has been formed.

Shake.—Shakes are given by females during social courtship on the water and perhaps these should be regarded as displays.

Nod-swimming of the same type as that given by males occurs during social courtship.

Preen-behind-wing.—Once I noted a female giving a Decrescendo call, then she performed a Preen-behind-wing display and as her mate swam up she Incited beside him.

Decrescendo.—This call usually contains 4 to 7 distinct notes, the first being longer and higher-pitched than the others. It is usually distinguishable from the Decrescendo of the Blue-winged Teal (*Anas discors*) by its squeaky quality.

I have seen the male of a pair react to his mate's Decrescendo by swimming toward her. At other times, however, a female will give the call as her mate stands beside her. Captive Green-winged Teal females gave Decrescendos in May when this call is rarely heard from Blue-winged Teal.

Loud, Repeated Quacks.—On the wintering grounds in Louisiana in March, the female of a pair gave a series of evenly spaced, grating quacks in flight. In Manitoba, similar series of calls were heard from birds on the ground in late May and early June, the notes being very loud, harsh, and quite high-pitched. Similar calls were given also by a captive female when she was introduced into a pen containing a group of males in early May. This bird gave bursts of squeaky quacking for several hours, while intense social courtship ensued.

SOCIAL COURTSHIP

Captives held overwinter in the Hatchery Building at Delta engaged in social courtship from the first week in February until mid-June. I have also seen apparently fully developed social courtship in an outdoor pen on a mild day in early October. In *crecca*, Lebret (1961) records it as early as 10 August, but in Holland he did not see it regularly until November while von de Wall (in litt.) believes that social courtship begins in September and continues throughout the winter. In the wild, the activity probably continues throughout fall, winter, and spring in *carolinensis* also. Social courtship groups are commonly seen in Manitoba during the spring migration in April. Most of these parties contain less than ten males, but once I saw a group of twenty-five males around a single female. In mid-March, virtually all Green-winged Teal I observed at the Rockefeller Refuge in Louisiana were paired and presumably the groups seen in Manitoba form around females with weak pair-bonds. Although paired males will leave their mates to join a social courtship group, most members of these groups appear to be unpaired males.

A social courtship group can be detected very easily by the loud and often continuous whistling calls of the males, audible for at least a half-mile in calm weather. The activity of the group is incessant, the males circling around the female, performing displays, chasing, and avoiding each other in a bewilderingly complex pattern of interactions.

Most male displays are performed with obvious relationship to the position of the female. Shake, Wing-flap, Burp, Grunt-whistle, and Head-up-tail-up are given as the male is broadside to the female. Turn-toward-female involves a rapid 90° turn following Head-up-tail-up, while Turn-back-of-head is carried out as the male swims away from the female. When the group is close to shore, males will come out on land and give Shake, Bridling, and Belly-preen broadside to the female. Down-up can also be given as the male is orientated laterally to the female but this display seems to be influenced also by the position of other males; it is given especially when males are close together. Bill-up is closely associated with hostility between males and it occurs not only during social courtship but commonly during encounters in the absence of a female. Males frequently adopt the Bill-up posture when facing one another.

Overt hostility between males is not obvious during short periods of intense social courtship activity, when males are most intent on directing displays to the female. But these bouts are interspersed with periods when chasing and fighting between males become predominant activities. I believe that hostility is present throughout all social courtship. Even when the performance of displays is the main occupation of males, the constant changing of position (usually achieved by Nod-swimming) appears to be influenced by movements toward and away from other males as well as the ever-present attempt to orientate the body with respect to the female.

From time to time, social courtship groups take wing and fly around for a short time (30 seconds to 4 minutes recorded). Often the group alights in the same place or close by. These courting flights appear to be merely changes in location of a social courtship group; the males continue to call in flight, but I have seen no special aerial displays.

Drink and Preening displays are not characteristic of the social courtship situation. They are performed mainly by a single male as he stands at the edge of the water beside the female. These displays are associated especially with the period immediately after a new pair-bond has formed.

The precise functions of social courtship and of the individual displays cannot be evaluated at this stage. As Weidmann (1956) found in the Mallard, paired males will leave their mates to join a social courtship group around another female. Basically, however, social courtship involves unpaired males and, at least during the latter part of the pair-formation season, it appears to play an important role in the process of mate-selection.

THE DISPLAYS OF THE TWO RACES

The European and American forms of the Green-winged Teal are now generally considered to be geographical races of one species (Delacour, 1956; Scott, 1957; Parkes, 1958). While the female plumage patterns are almost

identical, there are a few notable differences in the males. Most important are the conspicuous white streak on the scapulars of *crecca* (absent in *carolinensis*) and the equally striking, broad, vertical band of white on each side of the breast in *carolinensis* (absent in *crecca*). In the Eurasian race, the male has a number of distinct white lines on the face but these are absent or poorly developed in the American race. Less conspicuous are the finer vermiculations of *carolinensis* and the presence of rusty tips on the secondary coverts of this race.

These male plumage differences are minor compared with those existing between the Mallard and Black Duck and, as Johnsgard (1960) has shown, the major displays of these two forms are virtually identical in form, although there are quantitative differences in the frequency of some displays. Minor plumage distinctions also exist between the European and Pacific Eiders (*Somateria mollissima mollissima* and *S. m. v. nigra*) but there are both qualitative and quantitative differences in the display repertoire of these two races (McKinney, 1961). In view of the wide distribution of many *Anas* displays (Lorenz, 1953; von de Wall, 1963) we would not expect to find striking differences in the displays of *crecca* and *carolinensis* and this is indeed the case. Although there remain a few gaps to be filled by further study, it appears that both races have the same display movements. Detailed analyses would be required to determine whether there are quantitative differences comparable to those existing between the Mallard and Black Duck. Such a comparison would be of interest in the geographically isolated Green-winged Teal races in view of recent discussions of the possible function of such differences as isolating mechanisms in currently sympatric forms (Johnsgard, 1960, 1964). Also it may be that some differences in display frequencies have evolved in association with male plumage characters, notably the conspicuous white scapular and flank marks.

ACKNOWLEDGMENTS

This study was supported by the Wildlife Management Institute as part of the Delta Waterfowl Research Station program. I am especially grateful to Dr. H. Albert Hochbaum, Peter Ward, and Nan Mulder for their help during the observations and their efforts in maintaining the captive flock. I am indebted to Dr. Richard E. Phillips and Dr. Wolfgang von de Wall for reading the manuscript. Final work on the film analysis and manuscript and the collection of a series of still photographs was supported by the U.S. Atomic Energy Commission, Contract AT(11-1)-1332; Publication C00-1332-2.

SUMMARY

The displays of the American Green-winged Teal are briefly described. Most of the displays are performed during social courtship but a few occur when the members of a recently formed pair are alone. Most male displays are given with the body broadside to the female, but one involves facing toward her, another entails facing away. Two displays

are associated with the hostility between males. Displays recorded for the European race occur also in the American race and no differences in behavior of the two forms have been detected.

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ON THE AUTUMN MIGRATION OF THE BLACKPOLL WARBLER

Bertram G. Murray, Jr.

A nonstop, trans-Atlantic flight from New England to the Lesser Antilles and South America has been proposed for the Blackpoll Warbler (*Dendroica striata*) and, perhaps, other passerine species migrating in autumn (Drury and Keith, 1962; Nisbet, Drury, and Baird, 1963; Drury and Nisbet, 1964). The hypothesis is based on radar observations of southward movements of small migrants off the Massachusetts coast and the occurrence of warblers at Bermuda. Previously, Cooke (1904, 1915) proposed that Blackpoll Warblers converge toward the southeastern United States, and from there proceed southeastward toward the winter range in South America.

Information from the Island Beach Operation Recovery Station in New Jersey, as well as already published data, causes me to favor the hypothesis of Cooke, rather than that of Drury, Keith, Nisbet, and Baird, and to hypothesize further that the occurrences of Blackpoll Warblers at Bermuda are a result of wind drift.

The following discussion is restricted to the overwater flight of the Blackpoll Warbler from the United States mainland to Bermuda.

WIND DRIFT OF BLACKPOLL WARBLERS

Blackpoll Warblers occur most often at Bermuda during October (Nisbet et al., 1963). Of the 141 birds captured in 1962, 107 (76 per cent) occurred during the period 7 to 15 October. Another 17 occurred later, and only 17 occurred earlier (Table 1). Nisbet et al. (1963:132–133) suggested that the arrivals of 7 and 11 October "left North America south of New England. The latter suggestion seems more probable [than their leaving New England], since arrivals of light birds at Bermuda continued in 1962 (and in earlier years—Wingate *in litt.*) until the end of October, long after the last departures from New England." Most of the Blackpoll Warblers that reach Bermuda, then, leave North America from south of New England. In fact, Nisbet et al. (1963) report only one departure from New England that could account for arrivals at Bermuda—that on the night of 1–2 October. That departure was noted at Bermuda on 3 October by the arrival of 14 Blackpoll Warblers, which were captured by a lighthouse keeper during a sudden rainshower. Nisbet et al. (1963:133) concluded that the few Blackpoll Warblers at Bermuda in September and early October indicate "that the birds which migrate southwards from New England do not stop at Bermuda unless seriously delayed by the weather, although they pass overhead . . . ." It is with this last interpretation that I disagree. These 14 birds, as well as the others, can be considered

TABLE 1

NUMBERS OF BLACKPOLL WARBLERS CAPTURED AT ISLAND BEACH, NEW JERSEY, AND BERMUDA

	August–September					October			
	Island Beach			Bermuda[1]		Island Beach			Bermuda[1]
Date	1961	1962	1963	1962	Date	1961	1962	1963	1962
31	0	0	2	–	1	7	13	30	0
1	0	0	0	–	2	5	16	18	1
2	2	1	2	–	3	–	8	6	14
3	1	1	0	–	4	–	15	47	1
4	5	0	0	–	5	3	1	10	0
5	1	0	0	–	6	6	152	3	0
6	13	3	0	–	7	5	37	1	12
7	0	10	3	–	8	6	9	1	9
8	0	0	6	–	9	1	1	7	13
9	2	1	4	–	10	2	11	9	3
10	13	7	26	–	11	0	3	4	19
11	6	17	12	–	12	4	11	5	14
12	1	5	0	–	13	2	0	2	29
13	11	8	6	–	14	4	7	4	0
14	5	0	0	–	15	0	3	2	8
15	0	18	1	–	16	0	0	0	0
16	19	48	–	0	17	0	2	4	0
17	4	5	5	0	18	0	0	2	0
18	0	9	0	0	19	1	0	1	0
19	0	9	77	0	20	2	0	0	0
20	–	3	27	0	21	0	0	0	0
21	0	35	31	0	22	–	2	–	10
22	73	15	65	0	23	–	1	2	0
23	20	1	78	0	24	–	1	2	0
24	15	18	28	0	25	–	3	1	0
25	16	6	17	0	26	–	–	0	0
26	22	15	11	1	27	–	0	0	0
27	21	24	42	0	28	0	0	–	7
28	4	8	48	0	29	0	1	–	0
29	11	8	2	0	30	–	1	–	0
30	18	62	62	0	31	–	3	–	0

[1] Data from Nisbet et al. (1963:131).

vagrants, having been drifted offshore from the mainland by northwesterly and westerly winds. The following evidence and arguments seem relevant:

(a) The strongest evidence for the wind-drift hypothesis is the association of occurrences of Blackpoll Warblers at Bermuda and offshore winds (Tables 2 and 3). The wind on the night of 1–2 October, when the birds departed from New England, was westerly and northwesterly in New England and New York. The period 7–15 October, when 76 per cent of the Blackpoll

Table 2

Upper Air Wind Directions at 500, 1,000, and 1,500 Meters above Sea Level at Coastal Stations and Bermuda[1]

	Nantucket, Massachusetts			New York, New York			Washington, D.C.			Cape Hatteras, North Carolina			Charleston, South Carolina			Bermuda		
September[2]	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500
1	NE	NE	NE	SW	NE	N	SW	SW	S	NE	N	N	SE	E	NE	SW	W	SW
2	W	W	NW	—	—	—	NW	NW	SW	S	NW	N	SE	E	E	S	S	S
3	NE	N	N	—	—	—	NE	E	SW	SW	SW	NW	S	S	SW	S	S	S
4	NE	NE	N	—	—	—	SE	E	SE	S	SW	N	S	S	SW	W	SW	SW
5	NE	NE	N	SE	E	E	SE	S	SW	W	W	W	S	S	E	SW	SW	W
6	SE	SE	S	E	NE	W	NW	N	N	SW	W	W	SE	SW	SW	NW	NW	NW
7	N	N	N	N	NW	N	NE	N	N	NE	NE	W	E	E	E	W	W	W
8	NW	N	NE	SW	NW	N	S	SE	S	E	SE	SW	NE	NE	E	N	NW	NW
9	W	SW	W	SW	W	W	S	SW	SW	E	SE	E	NE	NE	E	NE	W	W
10	SW	SW	W	SW	W	W	S	SW	SW	SE	SE	SE	SE	SE	SE	E	E	E
11	—	—	—	SW	SW	W	SW	SW	W	S	SW	SW	S	NE	NW	E	SE	E
12	W	W	W	NW	NW	W	NW	W	W	SW	W	W	S	SW	NW	Calm	NW	W
13	NW	NW	NW	NW	NW	N	NW	W	NW	N	N	N	W	SW	NE	W	NW	NW
14	SW	W	W	SW	W	W	SW	SW	W	E	NE	E	E	E	N	N	N	N
15	W	W	W	W	W	W	NW	W	NW	S	W	W	SE	E	NE	E	E	N
16	W	NW	NW	W	NW	NW	W	NW	NW	NE	NE	N	S	S	E	E	SE	SE
17	W	W	NW	SW	W	NW	SW	S	S	E	S	SE	S	S	SW	SW	SW	W
18	S	S	S	SW	W	SW	SW	W	NW	SW	SW	SW	SW	SW	SW	S	S	SW
19	W	W	W	W	W	W	W	W	W	NW	W	W	E	N	NW	SW	W	W
20	W	W	W	NW	W	W	NW	NW	W	SW	SW	W	SE	SE	SE	—	—	—
21	NW	NW	NW	NW	NW	NW	NW	NW	NW	N	N	N	NE	NE	NE	—	—	—
22	W	NW	NW	NW	NW	NW	S	S	S	NE	E	S	NE	E	SE	—	—	—
23	S	SW	W	SE	S	S	E	SE	S	E	E	SE	NE	E	SE	—	—	—
24	NE	NE	E	NE	N	NE	NE	NE	NE	N	N	N	NE	NE	N	—	—	—
25	NW	NW	NW	W	W	NW	S	SW	W	NE	N	W	E	NE	NW	—	—	—
26	SW	SW	SW	S	SW	SW	SW	SW	W	S	S	SW	E	W	W	—	—	—
27	SW	SW	SW	SW	SW	SW	E	E	S	S	S	S	S	S	S	S	S	S
28	E	SE	S	E	E	SE	NW	W	SW	SW	SW	SW	W	NW	NW	S	S	SW
29	S	S	S	S	S	SW	W	W	W	W	W	W	W	NW	NW	S	S	S
30	SW	SW	S	W	W	W	N	W	W	W	SW	SW	E	NE	NW	S	S	S

[1] Data taken from the Daily Series, Synoptic Weather Maps, Part II, Northern Hemisphere Data Tabulations, published by the U.S. Weather Bureau.
[2] Blackpoll Warblers were captured at Bermuda on dates in bold face.

Table 3

Upper Air Wind Directions at 500, 1,000, and 1,500 Meters above Sea Level at Coastal Stations and Bermuda[1]

October[2]	Nantucket, Massachusetts			New York, New York			Washington, D.C.			Cape Hatteras, North Carolina			Charleston, South Carolina			Bermuda		
	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500	500	1,000	1,500
1	W	W	NW	W	W	W	S	S	W	E	SW	SW	E	SE	W	S	S	S
2	W	W	W	NW	W	NW	S	SW	W	E	E	NW	E	E	SE	SE	S	SE
3	W	N	N	SE	NW	N	SE	SE	S	S	S	S	E	E	SE	E	E	E
4	W	SW	W	SW	SW	SW	SE	SE	S	S	S	S	NE	N	N	E	E	E
5	SW	SW	SW	E	SE	SE	NE	N	NW	SW	S	S	E	W	SW	E	E	E
6	SE	SE	SE	NE	E	S	NW	NW	NW	NE	NW	W	NW	NW	W	SE	SE	SE
7	S	S	S	N	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	SW	SW	SW
8	NW	NW	NW	NW	NW	NW	NW	NW	NW	W	W	NW	W	W	W	W	W	SW
9	NW	NW	N	W	NW	NW	SE	SW	W	SW	W	NW	W	W	W	W	W	W
10	E	E	SE	E	NE	N	NW	NW	NW	N	NW	NW	NW	NW	NW	SW	SW	W
11	N	N	N	NW	NW	NW	NW	NW	NW	N	NW	N	W	N	N	NW	NW	W
12	W	W	W	W	W	NW	SW	W	W	SW	W	W	SW	SW	SW	N	N	N
13	W	W	W	W	W	NW	W	W	W	W	W	W	SW	W	SW	W	W	NW
14	NW	NW	NW	NW	NW	NW	N	NW	NW	NE	NE	NW	SW	SW	SE	W	W	W
15	W	NW	NW	SW	W	NW	S	SW	NW	E	NE	NW	E	NE	W	N	N	N
16	SE	N	NW	S	W	W	SW	W	W	E	E	E	E	E	E	NE	NE	NE
17	SW	W	W	SW	SW	SW	S	SW	SW	E	E	E	NE	NE	NE	E	E	S
18	NW	NW	W	NW	NW	NW	N	NW	NW	NE	E	NE	NE	NE	NE	E	SE	SE
19	S	W	NW	W	NW	NW	N	N	N	NE	NE	NE	N	NE	NE	S	S	S
20	SE	E	NE	SE	NE	N	NE	E	E	NE	NE	NE	N	N	NE	S	S	S
21	—	—	—	N	NE	N	S	W	NW	N	N	N	NW	NW	N	S	SW	SW
22	W	W	W	NW	NW	W	N	NW	W	W	W	W	SW	SW	W	W	W	W
23	NW	N	NW	W	W	NW	S	SW	W	N	NW	W	N	W	W	SW	SW	SW
24	SW	SW	SW	W	NW	NW	NW	NW	W	SW	W	W	W	W	W	SW	—	—
25	NW	NW	NW	NW	NW	NW	W	NW	NW	N	N	NW	NW	NW	NW	—	—	W
26	S	SW	W	SE	S	SW	S	S	SW	SW	SW	SW	W	W	W	S	SW	SW
27	W	W	W	W	N	NW	W	NW	NW	NW	W	W	NW	NW	NW	W	W	W
28	W	W	W	NW	W	W	SW	W	W	S	S	W	SW	NW	NW	N	N	SW
29	SW	SW	SW	SW	SW	SW	SW	SW	W	SW	SW	W	S	W	W	E	E	E
30	NW	NW	NW	NW	N	N	—	—	—	NE	NW	W	NE	N	NE	N	NE	N
31	SE	S	SW	W	S	SW	S	SW	SW	S	S	S	SW	W	SW	E	E	E

[1] Data taken from the Daily Series, Synoptic Weather Maps, Part II, Northern Hemisphere Data Tabulations, published by the U.S. Weather Bureau.
[2] Blackpoll Warblers were captured at Bermuda on dates in bold face.

TABLE 4

OCCURRENCES OF BLACKPOLL WARBLERS AND PRECIPITATION AT BERMUDA[1]

September	Precipitation (inches)	Blackpoll Warblers	October	Precipitation (inches)	Blackpoll Warblers
15	0.0	0	1	0.16	0
16	0.12	0	2	0.05	1
17	0.28	0	3	0.67	14
18	0.12	0	4	0.01	1
19	0.01	0	5	0.08	0
20	0.0	0	6	0.26	0
21	1.56	0	7	0.15	12
22	0.59	0	8	0.0	9
23	0.0	0	9	Trace	13
24	0.14	0	10	Trace	3
25	1.42	0	11	0.0	19
26	0.19	1	12	0.0	14
27	1.47	0	13	0.0	29
28	0.94	0	14	0.0	0
29	0.55	0	15	0.0	8
30	0.21	0			

[1] Captures of Blackpoll Warblers from Nisbet et al. (1963:131); precipitation from Surface Weather Observations, Kindley Air Force Base, Bermuda.

Warblers occurred at Bermuda, was characterized by persistent westerly winds along the eastern coast of the United States, as well as at Bermuda. The arrivals of 22 and 28 October also occurred when the winds were westerly.

That the mid- and late-October birds reach Bermuda by wind drift is not surprising. There seems to be no reasonable, alternative explanation of why birds departing from southeastern United States in a southeastward direction toward South America should occur on Bermuda.

(b) Nisbet et al. (1963) suggest that Blackpoll Warblers "do not stop at Bermuda unless seriously delayed by the weather. . . ." because of the 14 Blackpoll Warblers caught in the rain by a lighthouse keeper. However, most of the Blackpoll Warblers at Bermuda were captured by mist nets on days without rain (Table 4). Blackpoll Warblers seem to land at Bermuda whether it is raining or not.

(c) Blackpoll Warblers arrive at Island Beach from over the ocean (Murray, MS.; Murray and Jehl, 1964). Although a few are fat, most are light (Fig. 1; Murray and Jehl, 1964) and could not continue a long-distance flight. Assuming that Blackpoll Warblers are nocturnal migrants, the arrivals at Island Beach have flown between 10 and 11 hours. Blackpoll Warblers passing Bermuda would have flown over 30 hours (Nisbet et al., 1963). *Some* of the Blackpoll Warblers passing Bermuda would weigh about the same as Island Beach arrivals, and they could not continue a long-distance flight.

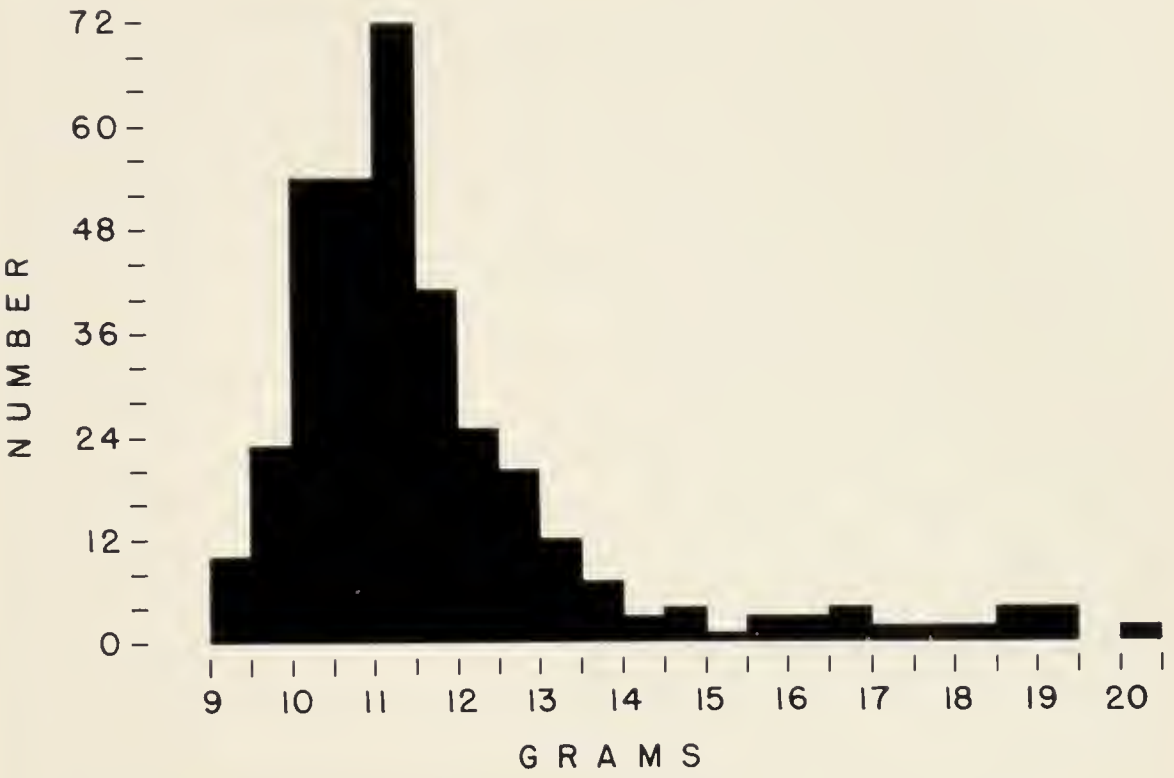

FIG. 1. Frequency distribution of weights of 352 Blackpoll Warblers captured at Island Beach, New Jersey, in September and October 1962. The weights are grouped in half-gram intervals—for example, the column to the left of "10" represents birds weighing 9.5 to 9.9 grams, and the column to the right of "10" represents birds weighing 10.0 to 10.4 grams. The mean of the sample is 11.7 grams.

Thus. Blackpoll Warblers should occur at Bermuda as frequently as they are flying near Bermuda.

(d) Blackpoll Warblers are captured almost every day at Island Beach during the migration from early September to mid-October (Table 1). Presumably, Blackpoll Warblers are regularly flying over or near New Jersey during this period. If Blackpoll Warblers are flying over or near Bermuda as regularly. I should expect them to occur more frequently than they do.

(e) Perhaps the most interesting anomaly reported by Nisbet et al. (1963) was the average weight of Blackpoll Warblers at Bermuda. which quite unexpectedly was higher than average weights from the mainland. Although Nisbet et al. (1963) state that light, as well as heavy, Blackpoll Warblers apparently depart on migration. they suggest the "normal departure weight" was between 19.7 and 23.2 grams. Such an hypothesis seems necessary if one were to account for the high average weight of Bermuda birds and for a 1.600 mile nonstop. overwater flight. However, only 46 birds. of their sample of over 2.000 from New England, weighed over 19.6 grams. That the weights of the extreme two per cent of the population represent the "normal departure weight" seems to me to be a tenuous hypothesis.

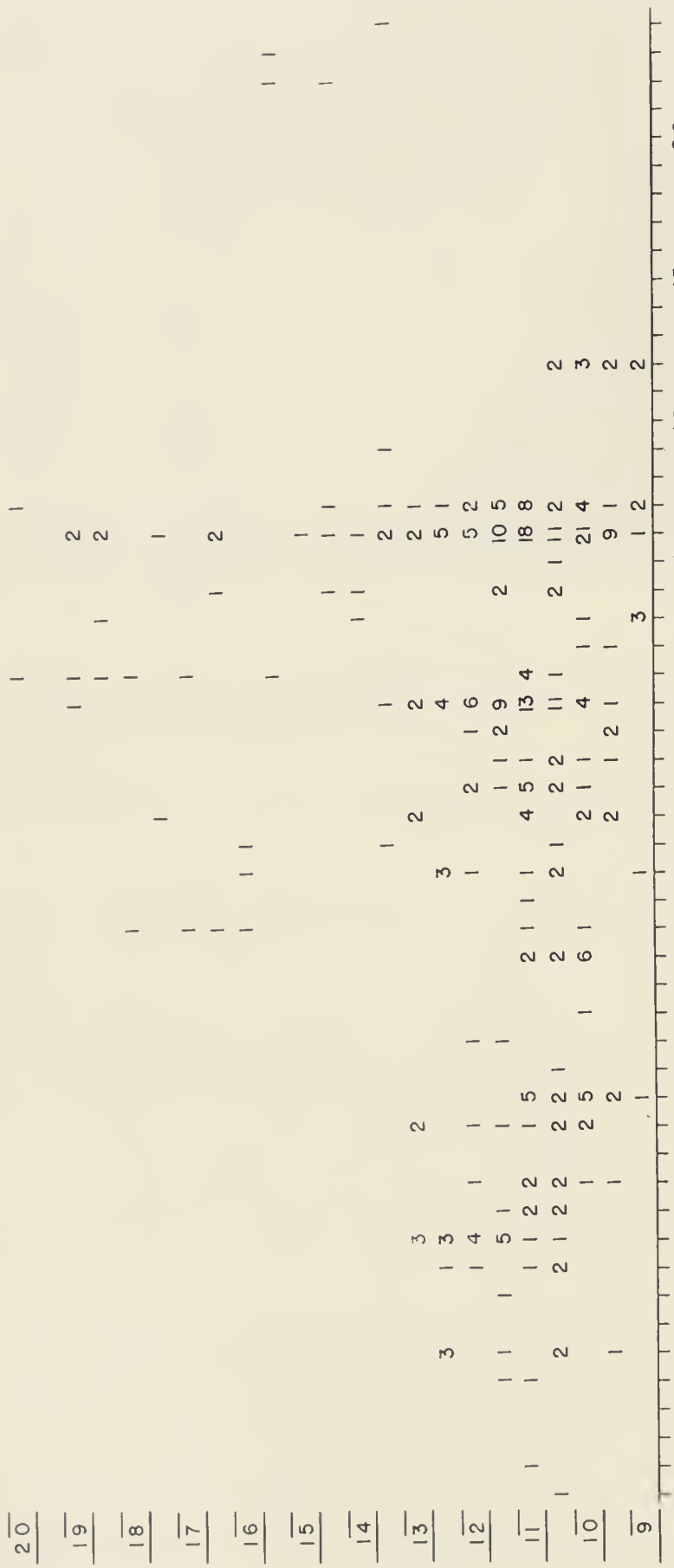

FIG. 2. Daily frequency distribution of weights of Blackpoll Warblers captured at Island Beach, New Jersey, in September and October 1962. The weights are grouped in half gram intervals—the row marked "10" contains weights from 10.0 to 10.4 grams, and the row above contains weights from 10.5 to 10.9 grams.

Alternatively, if the average departure weight were nearer the measured average weight (12–14 grams), the stored energy of the average bird would still be sufficient to sustain a night's flight. Birds of above average weight could fly longer, and birds below average weight could not fly as long. If a portion of the migrants were drifted over the ocean, only the fatter birds would have the potential of remaining airborne long enough to reach Bermuda. The distribution of weights of Blackpoll Warblers is skewed toward the heavy end (Fig. 1; Nisbet et al., 1963). If the preponderant lighter birds were to succumb, the average weight of the population that arrived at Bermuda could be higher than the average weight of the departing population.

The seasonal distribution of Blackpoll Warbler weights is of importance. During the first 3 weeks of September, there are no fat Blackpoll Warblers, either at Round Hill in Massachusetts (Nisbet et al., 1963) or at Island Beach (Fig. 2). Even though Blackpoll Warblers are migrating from the beginning of September (Table 1: Nisbet et al., 1963) on nights with offshore winds (Table 2), no Blackpoll Warblers reach Bermuda during this period, probably because too few (if any) Blackpoll Warblers have energy reserves sufficient to sustain the long overwater flight.

(f) The usual flight direction during the day of passerine migrants in autumn along the coast of the eastern United States is between west and north (Baird and Nisbet, 1960). These authors suggest that these northward-bound migrants are birds that had been drifted over the ocean and are returning to the mainland after reorienting. However, Drury and Keith (1962) and Nisbet et al. (1963) state that species involved in transoceanic migration were exceptions to this generalization, that is, transoceanic migrants do not reorient toward the mainland, while other species do reorient when drifted offshore.

At Island Beach the Blackpoll Warblers are common in autumn (Table 5), and they fly northward in company with other migrants. There is no evidence of a difference in orientation behavior between the Blackpoll Warbler and other species while over the ocean.

THE DRURY–KEITH ARGUMENT AGAINST WIND DRIFT

The possibility that wind drift may be the cause of occurrences of migrants at Bermuda was considered and rejected by Drury and Keith (1962) and was not further considered by Nisbet et al. (1963) or Drury and Nisbet (1964). The argument that led to the rejection of the wind-drift hypothesis is as follows:

"—those wood warblers which winter in Central America and northwestern South America, but not in the Antilles, do not turn up in Bermuda; whereas the wood warblers that winter chiefly in the Antilles and northern South America are numerous every autumn in Bermuda. This differential is inexplicable on the theory that Bermuda catches a

Table 5

Numbers of Warblers Captured at Three Coastal Netting Stations and Relative Abundance at Bermuda[1, 2]

	Bermuda Relative abundance	Nantucket, Mass.				Island Beach, N.J.				Ocean City, Md.			
		1958	1959	1960	Rank	1958	1959	1960	Rank	1958	1959	1960	Rank
Black-and-white	3	46	53	9	5	118	81	53	8	38	54	22	8
Prothonotary	3	0	0	0	–	0	1	0	–	0	1	0	–
Worm-eating	4	0	1	0	–	0	0	1	–	2	0	1	–
Golden-winged	6	0	0	0	–	0	0	0	–	1	1	0	–
Blue-winged	4	0	1	0	–	3	3	1	–	0	0	0	–
Tennessee	5	5	2	2	–	18	22	18	–	0	3	8	–
Orange-crowned	7	0	0	0	–	0	0	0	–	0	1	0	–
Nashville	6	11	0	6	17	23	30	41	16	2	4	13	17
Parula	3	3	7	4	19	14	25	33	19	1	6	7	19
Yellow	3	12	4	6	15	39	54	22	13	1	5	0	–
Magnolia	4	22	13	22	9	86	109	43	9	21	59	37	7
Cape May	2	49	25	70	3	102	123	91	6	9	57	32	10
Black-throated Blue	4	6	22	14	12	32	84	83	12	11	78	85	3
Myrtle	2	1	19	51	8	9	36	48	17	0	16	23	12
Black-throated Green	3	7	11	5	14	45	44	24	14	5	7	5	18
Cerulean	6	0	0	0	–	0	0	0	–	0	0	0	–
Blackburnian	4	3	3	2	–	13	13	6	–	0	3	3	–
Yellow-throated	4	0	0	1	–	0	0	0	–	0	0	1	–
Chestnut-sided	4	2	3	1	–	17	17	7	–	0	2	1	–
Bay-breasted	4	31	10	44	7	17	26	17	20	3	2	7	20
Blackpoll	1	15	39	49	6	127	141	212	3	13	31	79	6
Pine	8	0	0	3	–	1	0	0	–	0	0	1	–
Prairie	4	1	4	4	–	15	24	17	–	4	9	13	14
Palm	2	0	19	29	11	51	100	93	10	9	24	15	11
Ovenbird	2	18	24	14	10	95	64	55	11	43	43	40	5
Northern Waterthrush	2	69	67	41	2	161	205	58	5	51	54	41	4
Louisiana Waterthrush	4	0	0	0	–	0	0	0	–	0	0	0	–
Kentucky	4	0	1	0	–	0	0	0	–	0	0	0	–
Connecticut	6	4	2	1	–	22	58	29	15	3	16	17	13
Mourning	6	9	1	2	20	7	8	6	–	3	0	4	–
Yellowthroat	2	58	44	23	4	242	153	172	2	24	34	49	2
Yellow-breasted Chat	6	13	8	10	13	117	88	72	7	45	61	82	2
Hooded	3	0	2	2	–	3	1	1	–	1	0	3	–
Wilson's	6	11	3	4	16	18	20	14	–	5	13	5	16
Canada	6	8	4	5	17	39	30	16	18	13	1	11	15
American Redstart	2	122	122	78	1	533	452	241	1	136	179	162	1

[1] Relative abundance at Bermuda from Drury and Keith (1962:481): 1. Regular—abundant throughout; 2. Regular—common in suitable places; 3. Regular—several records per season; 4. Regular—single or a few records per season; 5. Frequent—common in suitable places; 6. Frequent—single or a few records per season; 7. Occasional—single or a few records per season; 8. Very rare.

[2] The period of operation of each Operation Recovery station differed. In order to facilitate comparisons, the number of birds captured during the period when all three stations were in operation are reported here. Dates (all stations in operation): 1958, 6–21 September; 1959, 5–27 September; 1960, 3 September–2 October.

random sample of drifted migrants from a broad-front southwestward migration . . ." (Drury and Keith, 1962:481).

and

"[Those species that migrate or winter commonly in the Antilles] Myrtle, Blackpoll, Palm, Ovenbird, Northern Waterthrush, Yellowthroat, and American Redstart are our commonest wood warblers and would be expected to predominate even if Bermuda records were of storm waifs and a non-selective sample. However, [those species that winter commonly in Central America] Tennessee, Nashville, Blackburnian, Chestnut-sided, Bay-breasted, Mourning, Hooded, Wilson's, and Canada Warblers are sufficiently common [in New England] to be expected to be represented on Bermuda in comparable numbers, if the arrivals there were simply drifted" (Drury and Keith, 1962:482).

In Table 5 are listed the numbers of warblers captured at the Operation Recovery Stations at Nantucket, Massachusetts; Island Beach, New Jersey; and Ocean City, Maryland, in 1958, 1959, and 1960, along with the relative abundance of warblers at Bermuda. The seven common species of Bermuda make up 57 per cent of the catch along the Atlantic coast. The nine species that Drury and Keith (1962) call "sufficiently common" along the coast make up only eight per cent of the catch. In fact, then, the common species along the Atlantic coast are common at Bermuda, and the relatively rarer species rare at Bermuda. Thus, the relative abundance of the species of warblers at Bermuda is exactly what one would expect, if a nonselective sample of the coastal migrants had been wind drifted over the ocean.

The Drury–Keith argument is further weakened by the fact that 83 per cent of the Blackpoll Warblers at Bermuda occur in mid- and late-October, when the birds almost certainly have been drifted from the southeastern United States (see paragraph (a) above).

THE SOUTHWARD MOVEMENTS ON RADAR

Perhaps the most interesting evidence in favor of the trans-Atlantic flight is the radar observations of southward movements of small migrants (Nisbet et al., 1963; Drury and Nisbet, 1964). "Southward movements occur regularly on the cold side of high pressure systems from late August until films stopped in early November, with the densest movements probably around the beginning of October" (Drury and Nisbet, 1964:85). Drury and Nisbet (1964) consider the late October and early November movements to be waterfowl, and Drury and Keith (1962), Nisbet et al. (1963), and Drury and Nisbet (1964) consider the earlier movements to be passerines. Specific identification of the landbirds is somewhat doubtful, the list of Drury and Keith (1962) being quite different from that of Drury and Nisbet (1964). Only the Blackpoll Warbler has been definitely assigned to the southward movements by Nisbet et al. (1963) and Drury and Nisbet (1964). However, the radar evi-

dence supporting trans-Atlantic migration of the Blackpoll Warbler is not entirely conclusive. Nisbet et al. (1963:115, 122, 126, 131) consistently state that Blackpoll Warblers do not depart from New England, at least in numbers, until after 25 September, much later than the onset of the southward movements observed on radar in late August. Even if Blackpoll Warblers were departing earlier, the peak numbers of mist-netted birds occur in Massachusetts in the last half of September (Table 4 in Nisbet et al., 1963) and in New Jersey in the last third of September (Table 1), whereas the densest southward movements observed on radar occur at the beginning of October. While the Blackpoll Warbler may form a part of the southward movements, other species are no doubt involved. What these are remains to be determined. The interpretation that the southward movements, which occur less than 70 miles offshore, are of passerines departing on a trans-Atlantic flight may be considerably altered when the species composition of the movements is known.

SUMMARY

The data and arguments supporting the trans-Atlantic flight of the Blackpoll Warbler are reviewed, and new evidence on Blackpoll Warbler migration from coastal banding stations is presented. The data, some of which were supposed to support the overwater flight, better support the hypotheses (1) that Blackpoll Warblers in the northeastern United States fly southwestward to the southeastern United States, before turning southeastward toward the winter range in South America and (2) that some Blackpoll Warblers reach Bermuda as a result of being drifted by offshore winds. The supporting evidence is (1) the association of occurrences of Blackpoll Warblers at Bermuda with westerly winds, (2) the low average weight of all mainland samples of Blackpoll Warblers, (3) the average weight of Blackpoll Warblers at Bermuda, which is higher than those from mainland populations, (4) the similarity in migratory behavior of Blackpoll Warblers and other species of passerines in coastal areas, and (5) the similarity in the relative abundance of warbler species in coastal populations and at Bermuda.

That the radar data on southward movements of small passerines are of Blackpoll Warblers departing on a trans-Atlantic flight is doubtful, because the radar data do not correlate well with the migration of the Blackpoll Warbler.

ACKNOWLEDGMENTS

Many persons assisted me directly or indirectly in the preparation of this paper. I have discussed various aspects of this problem with James Baird, Joseph R. Jehl, Jr., Jeff Swinebroad, and Harrison B. Tordoff. Chandler S. Robbins and John V. Dennis forwarded information from the Ocean City and Nantucket Operation Recovery Stations. Mrs. Stanley S. Dickerson and Mrs. Ben Warburton have allowed me to use the data from the Island Beach Operation Recovery Station. Allan H. Murphy assisted in obtaining the weather information. Earlier drafts of this paper were criticized by J. R. Jehl, Jr., Robert W. Storer, J. Swinebroad, and H. B. Tordoff. I am grateful for their assistance and for the work of the many banders who took part in the banding. I am also grateful for a grant from the Frank M. Chapman Memorial Fund of the American Museum of Natural History that made my fieldwork at Island Beach in 1963 possible.

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THE UNIVERSITY OF MICHIGAN MUSEUM OF ZOOLOGY, ANN ARBOR, MICHIGAN.
24 JULY 1964

DIFFERENCES IN FEEDING BEHAVIOR OF MALE AND FEMALE HAIRY WOODPECKERS

Lawrence Kilham

This report describes differences in feeding behavior of male and female Hairy Woodpeckers (*Deudrocopus villosus*) on diseased elms (*Ulmus americiana*) in the vicinity of Lyme, New Hampshire, where these differences were most apparent, as well as on other trees, some of which were located in Tamworth, New Hampshire and in Seneca, Maryland in years from 1960 to 1964.

In the last year of more intensive study I was in the field for approximately an hour, on nearly every day of the week, usually in the early morning. In making observations on feeding behavior I kept a record of the species of tree, whether it was living or dead, on which part the woodpecker was active, such as trunk, limb, branch, or twigs, as well as noting the sex of the individuals, the particular individual as known by its head markings (see Kilham, 1960), and finally the manner of feeding.

FEEDING BEHAVIOR

The ways in which Hairy Woodpeckers extracted prey from within trees were separable into two categories: the uncovering of prey within bark or in wood immediately below and the extraction from deeper layers. These methods are described below in terms of behavior patterns involved.

Location and securing of superficial prey

Percussion.—Hairy Woodpeckers progressing along a limb may give rapid blows here and there to locate prey presumably by causing it to move or by a differential in reverberations between a tunnel and solid wood. On 11 January 1960, I watched a female in Seneca Swamp, moving up a limb of a red oak (*Quercus rubra*) percussing all the way. She swung her head in a sweeping motion as she gave blows at one angle and then at the opposite. The bill of *D. villosus* seldom describes a straight to and fro motion in such circumstances. The bill appears to be open the whole time, but after examining dents in birch bark made by a percussing female I believe that the bill closes on striking. The location and extraction of bark beetle larvae by the Great Spotted Woodpecker (*Dendrocopus major*), the European counterpart of *D. villosus*, is described by Sielmann (1959).

Pecking.—This is the uncovering of prey with relatively few blows against the bark or superficial layers of wood.

Peering and Poking.—Hairy Woodpeckers sometimes move up a tree peering and poking after prey without resorting to blows, in a manner suggestive of Brown Creepers (*Certhia familiaris*).

Scaling.—This can be the knocking off of bits of outer bark or of dead bark with exposure of underlying wood.

Extraction of prey from deeper levels

Excavation.—Extraction of larvae from tunnels ¼ inch or more deep in hardwood may take 15 or more minutes of exertion at a single spot where the woodpecker hews out splinters, often seizing them in its bill to shake them loose or to toss them aside. Excavation of this type is characteristic of male Hairy Woodpeckers.

Scanning from a distance.—Another characteristic of males is that they may hitch up tree trunks in slow, deliberate fashion, tipping their heads to one side, then the other, when obviously in search of places to excavate.

Actual Feeding

Hairy Woodpeckers make fine, vibratory motions with their heads when feeding in tunnels and crevices. These are associated with an extremely rapid darting of the tongue, almost snake-like, to a distance of ½ inch beyond the tip of the bill, as I have observed with hand-raised individuals. When one of them explored my fingers with its tongue, the rapid movement felt like a fine jet of sand flicking about over the skin. On close inspection this darting appears to remove obstructing frass as well as larvae from tunnels. When swallowing larger forms of prey, the woodpeckers make opening and closing motions with their bills.

FEEDING ON ELMS

In the spring of 1963 I began to notice that practically all of the Hairy Woodpeckers feeding on elms dying of the Dutch elm disease in Lyme were females. This fact led me to start a more detailed study in midsummer. The adult woodpeckers had largely finished molting and caring for their young by this time and I was able to observe their feeding behavior in a fairly regular fashion until they ceased visiting the elms with an onset of cold weather, well below freezing, in early December. Table 1 summarizes observations made in this period of August through November. It is apparent that there was a sexual difference in attendance on the elms, since 19 of 20 woodpeckers feeding on them were females. Although I was in the field with equal frequency through all months of the year, I had only three observations of Hairy Woodpeckers feeding on dying elms in December and January. By February, however, they were feeding on them more frequently and I began a second period of observations in which the woodpeckers were often seen together, following pair formation in January. Table 1 summarizes these observations, made from February through April. It is again apparent that the females made the most visits to the elms, for they were seen feeding on 31 occasions as compared with only 2 for the males.

TABLE 1

NUMBERS OF FEEDING VISITS BY MALE AND FEMALE HAIRY WOODPECKERS TO DYING ELMS AS OBSERVED IN TWO SEASONAL PERIODS

Period of observation	Sex	Trees fed upon		Summary		M and F together
		Dying elms	Other	Total trees	Per cent on elms	
1963						
August	F	19	8	27	70%	
through						Rarely
November	M	1	19	20	5%	
1964						
February	F	31	54	85	37%	
through						Frequently
April	M	2	44	46	4%	

A number of aspects of the above situations not brought out by the figures alone were the following:

Behavior of females on elms.—Females of *D. villosus* displayed much energy when working on elms. They pecked, hewed, struck glancing blows, seized bits of bark in their bills to waggle them loose in an almost furious manner, then tossed them away, all at a faster, less interrupted pace than was usual on other trees. This tempo might be maintained for as long as half an hour. During this time a female would progress slowly along a limb, leaving it light brown in color due to an almost uniform removal of outer bark.

Behavior of males.—Although male Hairy Woodpeckers were feeding on dying elms on three occasions (see Table 1), their feeding was never as vigorous or prolonged as that described for the females. While one of the occasions was observed too briefly for analysis, circumstances attending the other two were noted in detail.

(a) On 8 February 1964, a female was working on an elm in typical fashion when her mate flew over and supplanted her. He pecked for several minutes on a light brown place from which she had already removed the outer bark, then flew away.

(b) On 4 April 1964, I found a pair of Hairy Woodpeckers working together on a dying elm. This was the only time I ever observed a male feeding on one of these trees in any prolonged manner. Since the female was working 6 feet above him, I had an opportunity to compare the feeding behavior of both sexes in extracting prey from the same type of bark. She worked rapidly with short to and fro, as well as horizontal motions of her head as she percussed and scaled off bark in strips up to 4 inches long. The sound from these activities was fast and regular. Her mate on the other hand, would give a number of deliberate blows, each accompanied by a full swing of the head.

pause, then give a few more. His activities as well as hers were seemingly limited to the bark itself. The male progressed only a foot up the trunk in the 15 minutes before he flew away. She continued to feed for a longer period.

Several points in the above episodes were noteworthy. The male in the first one appeared to have an urge to dominate at a feeding situation, even though it was one in which he had no interest, as shown by the fact that he flew away shortly afterward. The second episode was possibly more complex. Here the male and female used different patterns of behavior when feeding under essentially the same conditions. It appeared as if the male by "habit" or "innate" behavior was unable to work in the manner of the female which may have been the more effective one under the circumstances. This concept might explain why males came to elms so infrequently. Being unable to adapt themselves readily to bark feeding, they move to trees where their methods will uncover more food for less effort.

Added support for the above observations on sexual differences were contributed by Mr. Howard Hutchins of Lebanon, New Hampshire, who had an elm dying of Dutch elm disease in his backyard. In a record kept from November to April he observed female Hairy Woodpeckers feeding on the elm 18 times and a male only once.

Time of feeding young.—The only Hairy Woodpecker which I observed feeding on elms during May, June, and July, 1964, was Female B. Her nest was located 100 feet from a dying elm. Between 29 May, when I found the nest, and 12 June when the young emerged, she visited it repeatedly in gathering prey to feed them. I never observed that her mate did so. After three fledglings had left the nest on 12 June, I watched one of them following its mother up the trunk of the elm being fed every few minutes. On the following morning I found the two on another dying elm 200 yards from the nest carrying on as before. When next seen on an elm, on 18 July, Female B was feeding alone.

I had considerably fewer observations of Hairy Woodpeckers feeding from May through July, than in earlier months when trees were bare of leaves. July was a low point in numbers of observations in both 1963 and 1964. Although molting of the woodpeckers may have contributed to this situation, an additional factor may have been that the native elm bark beetle *Hylurgopinus rufipes* exists primarily in the form of developing eggs and small larvae which may not attract woodpeckers to dying elms until they reach a greater size. Kasten (1939) has written a life history of this species and gives description of its various stages of development throughout the year.

Putting observations together, it is likely that at least 20 female Hairy Woodpeckers in two townships were included in the above studies.

TABLE 2

CONTRAST IN FEEDING HABITS OF MALE AND FEMALE HAIRY WOODPECKERS ON VARIOUS TREES EXCLUSIVE OF ELMS. (August 1963 through April 1964)

Sex	Type of feeding	White pine	White birch	Yellow birch	Black cherry	Maple	Red oak	Aspen	Other trees	Summary Totals	Summary Per cent
M	Superficial	0	0	—	6	2	0	2	0	10	12.3
	Deep	1	5	—	10	23	18	11	3	71	87.7
	Totals	1	5	—	16	25	18	13	3	81	100
F	Superficial	22	17	15	4	12	1	2	5	78	87.7
	Deep	1	4	0	1	3	0	0	2	11	12.3
	Totals	23	21	15	5	15	1	2	7	89	100

FEEDING ON TREES OTHER THAN ELMS

Observations on Hairy Woodpeckers were made almost entirely in woodlands which represented their home ranges since I wanted to study breeding and other habits as well as the spectrum of their feeding behavior, which might not have been possible close to houses and feeding stations. In covering these wider areas I found that some of the findings relating to elms were also encountered on other types of trees.

White pines.—Table 2 shows that there were 23 observations of female Hairy Woodpeckers feeding on white pines (*Pinus strobus*) as compared with only one for males. The feeding was of serveral types. In three instances, all in winter, females sought prey by peering and poking as they moved up the rough bark of field-grown pine. This manner of feeding was also observed for Downy Woodpeckers (*Dendrocopus pubescens*). Other instances were on pines with bark more or less adherent, which females scaled, sometimes from areas a foot or more in extent or knocked from the small region where a limb entered the trunk, particularly in pines which were still living.

Hardwood trees.—When male Hairy Woodpeckers were observed feeding, they were usually excavating the dead trunks or limbs of aspens (*Populus tremuloides*), black cherries (*Prunus serotina*), red oaks (*Quercus rubra*), and maples (*Acer saccharum* and *A. rubrum*). These trees occurred mainly in two types of situations, either along stone walls and dirt roadways which had protected them from lumbering or in fairly mature woods. When members of a pair were feeding together in such situations the female might feed on dying elms if by the roadway, or on white (*Betula papyrifera*) and yellow (*B. alleghaniensis*) birches if in woodlands. There were two ways in which

the sexes differed; first that they tended to work on different species of trees and second, to seek prey by different methods (Table 2). These differences were not absolute. Females were percussing, pecking, poking, or scaling to reach their prey (superficial types of feeding) in 87% of observations and excavating (designated as deep type of feeding in Table 2) in only 12 per cent. Percentages for males in these types of activities were exactly the reverse.

CHANGE OF FEEDING BEHAVIOR IN LATE SPRING

Both male and female Hairy Woodpeckers adopted an additional pattern of feeding as new insect populations emerged in the spring. On 4 and 5 May 1964, for example, Male B picked insects from the base of one white birch after another while his mate, in the same group of trees, seized them by fluttering up against the bark of the trunks. Neither did any pecking or excavating. There was nothing specific about this behavior as White-breasted Nuthatches (*Sitta carolinensis*) and Downy Woodpeckers were observed feeding in similar fashion on the same mornings.

Hairy Woodpeckers caught much of their prey from surfaces of trunks and branches when feeding their young. I had a favorable opportunity to observe this with Pair B. Each parent would remain near the nest when the other was away, spending much of its time looking for insects on adjacent trees at the edge of a pasture. Although the two birds behaved alike some of the time, Female B was usually the more active, seizing prey as she happened to come upon it when moving rapidly about, without resorting to percussing or pecking. Her mate was nearly always more deliberate. As is the case for male Hairy Woodpeckers searching for a place to excavate on oaks or other trees, Male B might move slowly from one perch to another, flying over to seize an insect only when he had first spotted it from a distance.

SIZE OF PREY

It is possible that the habit of excavating to which the males of *D. villosus* are especially inclined leads them to feed on larger sized prey, on the average, than do females. While this situation is difficult to prove, I have observed situations where they caught excessively large grubs. One of these was on 23 March 1964, in Tamworth. A male had been working on a well-rotted birch when he pulled out a larva so large that he was unable to swallow it on the first attempt. He made no effort to dismember it. When he had finally forced the grub down, he remained motionless for some minutes with eyes closed to slits, as if uncomfortable with the immediate effects.

A second instance was on 5 June 1964, in Lyme. I was watching for Male B when he arrived at his nest hole with a grub nearly 2 inches long and ½ inch wide, which he tried without success to poke down the throat of an awaiting young one. The grub may well have been the larva of the sugar

maple borer (*Glycobius speciosus*). Male B next flew to the woods. To my surprise he returned still carrying the grub and made a second attempt to feed it to a young one. After several more attempts, interspersed with clumsy efforts to lodge the larva in various crevices and shake it, as if into smaller or more flexible pieces, he forced it into a young one on the fifth attempt.

A revealing aspect of the two above episodes was the relative ineffectiveness of *D. villosus*, in comparison with such species as the Red-headed Woodpecker (*Melanerpes erythrocephalus*) (Kilham. 1958*b*) in dismembering large prey.

FEEDING BEHAVIOR WITHOUT SPECIAL DIFFERENCES

Hairy Woodpeckers of both sexes may feed in more or less similar fashion under a variety of conditions, among which are:

Feeding on ground.—Males and females may both come to the ground to feed. but do so most extensively in early spring. It is probable that some forms of bark beetles become especially available at this season for, as stated by Graham (1963:218) those established in fallen stems and covered with snow in winter may escape the fatal effects of low temperatures. Several episodes illustrated the behavior of *D. villosus* in weeks following the melting of the snow.

On 20 April 1963 I was able to follow a female Hairy Woodpecker for ¾ of an hour as she hopped along the ground or flew from the base of one tree to another in a mixed woodland. She worked on one stick half-buried in leaves for 15 minutes. It seemed possible on this and on other occasions after a rain, that *D. villosus* may be especially attracted to the ground when sticks and logs are well soaked.

On 6 May 1963 I followed a male who spent 35 minutes working over logs, stumps, and branches left by a lumbering operation. The slash was a mixture of hardwoods and hemlock. At one log the male clung with body parallel to the ground at the juncture of earth and wood.

Suet.—About a dozen Hairy Woodpeckers recognized by individual head markings (Kilham. 1960), came to our suet holders in winter. Female B, whose roosting habits I observed for some months, flew exactly a mile to reach our suet nearly every morning, her actual course involving stops on a number of trees. Later in the year both males and females brought juvenile young to feed them on suet directly. The holder was well used in July after some months of comparative neglect.

Sap.—The following examples illustrate that Hairy Woodpeckers of both sexes take sap in spring.

On 29 March in Tamworth and on 1 April 1963 in Lyme I observed males visiting maples where sap was streaming down the bark from fissures made by wind damage in winter or possibly by bites of red squirrels (*Tamiasciurus*

hudsonicus) (Kilham, 1958*a*). The woodpecker imbibed drops wherever they happened to form.

Sapsuckers (*Sphyrapicus varius*) take sap from aspens in late April, drilling bands of holes on branches at a time when catkins are elongating. These were the only sapsucker holes where I observed *D. villosus*. On 18 April 1964 both members of a pair of Hairy Woodpeckers fed at the holes on one aspen at the same time and on 28 April, a female took sap from another aspen when the owning female sapsucker was feeding only 6 feet away in seeming indifference to the intruder. When a Myrtle Warbler (*Dendroica coronata*) came to take sap, however, the sapsucker drove it away immediately.

COMPARISONS WITH OTHER SPECIES

Pileated Woodpeckers.—There are resemblances between the smaller excavations of Pileated Woodpeckers (*Dryocopus pileatus*) and larger ones made by males of *D. villosus*. This is especially true when Hairy Woodpeckers are working on soft wood. On 17 November 1957 I located a male by the blows he was making on a dead poplar (*Populus heterophylla*) in Seneca Swamp. He would loosen a chip in vigorous fashion, seize it in his bill, then toss it away in a manner not unlike that of *D. pileatus*. Some of the chips falling onto a pile below were several inches long. The Hairy Woodpecker made a sizable hole within a relatively short time, which I might have mistaken for the workings of the larger species had I come by later.

Hairy Woodpeckers occasionally take advantage of the excavations of *D. pileatus* to feed more deeply within trees than they could by their own exertions alone. I observed this on 16 March 1963, in Tamworth, when a male flew to an excavation of *D. pileatus* which was about 5 inches deep and 4 inches wide in the base of a sugar maple, and entered completely. After tossing out a few chips he enlarged the holes with blows of his own, making feeding motions as if finding prey. He may have been finding larvae of the pigeon horntail (*Tremex columba*) as far as I could determine from a subsequent inspection, but he was not at ease in his operations. He came out several times to look about. A Pileated Woodpecker was 50 yards away the whole time, pecking loudly and making random *cuks*, but it was 20 minutes before it came any closer. The Hairy Woodpecker flew out immediately. I apparently frightened the Pileated, for three times it flew nearly to the excavation, but shied away at the last moment.

Downy Woodpeckers.—Females of *D. villosus* paralleled Downy Woodpeckers in feeding on dying elms, but it seemed curious to have encountered *D. villosus* infrequently and *D. pubescens* with considerable frequency on these trees in Maryland (Kilham, 1961), the reverse of the situation in New Hampshire. The fact that in Lyme the native elm bark beetle and in Seneca, the

European beetle (*Scolytus multistriatus*) were the ones encountered may have made this difference.

An opportunity to observe interrelations between *D. villosus*, *D. pubescens*, and Yellow-bellied Sapsuckers arose from a situation in Lyme. This centered on a group of white birches drilled by a family of sapsuckers in the summer of 1963 and next to them, a dying elm. A female Downy Woodpecker visited the drill holes many times a day but I never observed it on the elm. In contrast a female Hairy Woodpecker fed on the elm not infrequently, but took no interest in the birches. The sapsuckers occasionally drove away the Downy Woodpecker. They likewise took no apparent interest in the bark beetle larvae, although they often rested on the bare limbs of the elm.

Three-toed Woodpeckers.—Black-backed Woodpeckers (*Picoides arcticus*) take advantage of wind-blown trees to feed on larvae of engraver beetles, as I have observed on mountaintops as well as at the Connecticut Lakes in northern New Hampshire. This species occasionally moves southward in the nonbreeding season. When out of their normal habitat they feed on two types of trees which are especially attractive to females of *D. villosus*, namely dying elms and white pines. West and Spiers (1959), for example, found that a number of observers of one invasion reported *P. arcticus* as feeding on elms dying with the Dutch elm disease, with an uncovering of the fawn-colored, inner bark. Reports on the attraction of dead white pines for Black-backed Woodpeckers are presented by Van Tyne (1926). I had a similar experience in Tamworth on 22 September 1962 when I watched a male scaling bark for 30 minutes on a white pine which I had cut down the previous April.

EVOLUTION OF SEXUAL DIFFERENCES IN FEEDING HABITS

The observations presented here suggest that male and female Hairy Woodpeckers differ in some types of feeding behavior and may in this manner make a more effective use of their environment. One might imagine that the male's habit of excavating for wood-borers would insure a fairly constant food supply from dead limbs and trunks in a forest of large trees. No environments, however, are completely stable. Areas of blowdown would provide niches of fallen trees favorable to proliferation of bark beetles. The Dutch elm disease has been similar to such blowdowns in providing food supplies for new populations of such insects and secondarily, for female Hairy Woodpeckers feeding upon them.

It would seem likely that the sexual differences in feeding habits of *D. villosus* have resulted from several selection pressures. A few of these are considered below in relation to concepts of other investigators as well as to details of the breeding season when the differences may be particularly advantageous.

Lack (1944) has presented an hypothesis that species with identical feeding habits will not occupy the same areas and conversely that those occupying the same habitat must have differences in feeding habits. This concept has led Rand (1952) to raise the question of whether the same can apply to males and females of a single species. In the Huia (*Heteralocha acutirostris*), for example, the female was able to reach some wood-boring grubs with her long, curved bill which were not accessible to the male with his short, straight one. There are also ways for reducing competition for food other than such structural devices. Rand has further pointed out that it is not uncommon for females of various species to migrate farther south in winter than males, a situation which Howell (1953) has described for Yellow-bellied Sapsuckers.

Opinions differ as to what constitutes competition. Andrewartha and Birch (1954) have defined it as the seeking of a resource which is in short supply by a number of animals. If one applies this concept to the sexes of *D. villosus*, it is obvious that they do compete under certain circumstances. At a suet holder, for example, a male coming in will almost invariably drive away a feeding female. On the other hand, there appears to be no evidence of any shortage of food on a large breeding territory which agrees with Andrewartha and Birch's further statement that natural populations consume only a small proportion of food in their areas. It is possible, however, that the situation may appear less simple to a male Hairy Woodpecker. One can imagine that some supplies of food are more desirable to him than others, due to their accessibility, quality, or other differences, and that most trees in his territory are of relatively little interest from his point of view. What he seeks on his rounds are often special stubs well supplied with larvae he can reach. This situation can be represented by an episode observed in Tamworth in 1963. Male D had been coming to a white birch stub containing sizable larvae. When he returned on 23 March, Male E was excavating the stub, apparently lured to it from his own territory. Male D approached the intruder making shrill *wick-a-wick* notes and performing a bill-waving dance. His rival left immediately. If the members of a pair of Hairy Woodpeckers had similar food habits they would presumably be attracted to such stubs at the same time, on occasions, and the male would drive the female away as at a suet holder. Such competition could be disadvantageous, especially so if one considers that at least 3 months of the breeding period are largely involved in building up social bonds which will enable the members of a pair to meet the hazards of raising young in effective cooperation. Friction arising from repeated competition would tend to weaken the pair bond at a crucial period. It seems possible, therefore, that selection pressures could act to promote differences in feeding, roosting, and other habits where competitive friction might arise.

Another probable advantage of sexual differences in feeding habits relates to the location of nests. Nesting sites which are really suitable for *D. villosus* appear to be scarce. A pair will usually select a living tree with a rotten center, providing that it is a safe distance from the ground and of the right diameter. There is little indication that they pay much attention as to whether the tree is in a particularly good feeding area. Thus, three of four nests found in 1964 were located rather unfavorably with respect to food as judged by the distances the parents had to fly to obtain it for their young. The fourth, however, was well located in this respect. Thus, as described above for Pair B, the female fed her young repeatedly from a nearby elm while her mate was able to obtain larger grubs from other trees not far away. 1964 was an average year in regard to weather. In an adverse season of cold and wet. however, the fact that the male was adept at securing one kind of food and the female another might enable them to work the more limited resources of their immediate environment to best advantage in the task of feeding themselves and young.

A point in conclusion is that *D. villosus* may not be uniform in habits throughout its continental range but consist of local populations or demes adapted to particular climates, types of woodland, insect populations, and sets of avian and other competitors making up their immediate environments. Such descriptions as I have given above may not fit all localities. Ecologic conditions, furthermore, are in a constant state of change with tree diseases due to insects (Van Tyne, 1926), blowdowns, floods (Yeager, 1955), and fires (Blackford, 1955) providing opportunities for observing the adaptability of woodpeckers. These situations can serve as natural experiments like the Dutch elm disease in New Hampshire. While the above account of Hairy Woodpeckers has been focused on interpretation of a natural experiment in sexual variation in feeding habits, it is part of continuing studies of the breeding and agonistic behavior of *D. villosus* in relation to its total ecology.

SUMMARY

Observations on elms dying of the Dutch elm disease in central New Hampshire indicated that Hairy Woodpeckers were the only ones to avail themselves of the new food supply represented by the bark beetles, in any sustained fashion.

The elms attracted females almost exclusively. In seeking an explanation for this phenomenon a year around study was made of both sexes, with attention to the types of trees on which they fed and their manner of doing so. It then became apparent that females of *D. villosus* differ from males in much of their feeding behavior and are especially adapted to feeding on bark beetles. The elm disease gave expression to a potential which would have been less striking under usual circumstances.

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NESTING HEIGHTS OF SOME LOUISIANA BIRDS

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In certain studies conducted on birds, the nest-height position in relation to the ground has received some consideration. The investigations by Lashley (1915), Whitman (1919), and Allen and Mangels (1940) indicate that the nest-height position exerts a strong influence on the breeding birds. When Preston and Norris (1947) analyzed the heights of 741 nests in a 2-year study, they found: "That within a given species, some individuals persistently nest high and others low, and that an individual does not vary its nesting height over the whole range used by the species." Also, they state that in examples of typical woodland and bushgrown countryside, the greatest density of birds' nests is at ground level; however, in suburban areas of "perpetual alarms," the greatest density of nests is above the ground. In recent years, game managers have given considerable attention to the location of nests. Such studies, according to Davis (1955), are significant to discern the size and change of population and "from the speciation viewpoint, the analysis of variation in nesting site may provide information about trends in evolution." According to Baerg (1931), knowing the exact site of the nest is a valuable aid in the identification of the structure. Since most of the previous research on this subject has been on species in the northern portion of the United States (see Preston and Norris, 1947; Brackbill, 1950; Mayfield, 1952; and Cruickshank, 1956), this is the first investigation done in the state of Louisiana, or in the remaining Southern states on the heights of birds' nests above the ground.

The observations were made during the breeding season of 1963 in northern Louisiana, primarily on the campus and farm of the Louisiana Polytechnic Institute, Ruston, Louisiana. Searches for nests were also made in areas such as grasslands, lake and pond shores, and woodlands in a variety of places as cemeteries, yards, farms, and the campus.

A total of 522 nests representing 28 species, 17 families, and five orders of birds was found. The ten species, for which nine or more nests were located, the number of nests, the highest and lowest nests, and the mean height in feet are tabulated in Table 1. The mean height for the 522 nests was 9.1 feet from the ground.

The height range above the ground for the 522 nests is 0 to 50 feet. In this range, 415 nests (79.5%) were from 0 to 12.5 feet, 86 nests (16.5%) from 13 to 22.5 feet, and 21 nests (4.0%) from 23 to 50 feet above the ground. Furthermore, 237 (45.4%) of the 415 nests ranged from 0 to 6.5 feet while 178 nests (34.1%) were 7 to 12.5 feet above the ground. Ninety-five (18.2%) of the 237 nests were below 3.5 feet and 142 nests (27.2%) were found from 4 to 6.5 feet from the ground. The major difference between the data given

TABLE 1

NEST-HEIGHT DATA OF TEN SPECIES

Species	Number of nests	Lowest nest	Highest nest	Mean height in feet
Zenaidura macroura	30	8.0	26.5	12.7
Cyanocitta cristata	19	4.5	25.0	13.1
Mimus polyglottos	151	1.5	29.0	7.9
Dumetella carolinensis	11	3.5	12.5	7.4
Toxostoma rufum	108	1.5	18.0	7.9
Turdus migratorius	20	5.0	22.5	12.8
Lanius ludovicianus	9	7.5	29.0	13.2
Passer domesticus	35	9.0	50.0	20.8
Agelaius phoeniceus	48	1.0	17.0	4.3
Richmondena cardinalis	39	3.0	24.0	6.3

TABLE 2

THE DISTRIBUTION OF 470 NESTS

Species/Height (feet)	0–3.5	4–6.5	7–9.5	10–12.5	13–15.5	16–18.5	19–21.5	22–24.5	25–27.5	28 over
Zenaidura macroura			11	9	4	1	2	2	1	
Cyanocitta cristata		1	4	5	4	1	1	2	1	
Mimus polyglottos	27	48	38	17	12	5	1	1	1	1
Dumetella carolinensis	1	4	3	3						
Toxostoma rufum	15	37	22	19	10	5				
Turdus migratorius		3	2	5	3	4	2	1		
Lanius ludovicianus			5		2		1			1
Passer domesticus			2	6	4	7	4	4	1	7
Agelaius phoeniceus	28	13	5	1		1				
Richmondena cardinalis	6	24	5	3				1		

by Preston and Norris and these data is that they found a higher percentage (44.0%) of nests at the 0- to 3-foot level, as compared to the lower percentage (18.2%) of nests in my study at about the same level above the ground. This difference is apparently because Preston and Norris found a greater number of low nesting species. Table 2 gives the distribution of heights of 470 nests.

According to the season, an individual bird may nest at different heights above the ground (Welty, 1962). Nice (1937) has shown this variation with the Song Sparrow, Walkinshaw (1939 and 1944) with the Field and Chipping Sparrows. Lawrence (1953) on the Red-eyed Vireo, and Laskey (1962) with the Mockingbird. The averages of the heights of new nests of the Mockingbird and the Brown Thrasher found at the given months are presented in Tables 3 and 4. The results indicate that nests of these species are placed at higher elevations as the season progresses.

TABLE 3

MEAN HEIGHTS IN FEET OF 127 NEW NESTS OF *Mimus polyglottos* FOUND IN THE GIVEN MONTHS

Month	Number of nests	Mean height in feet
March	2	4.5
April	34	5.5
May	7	8.1
June	45	9.2
July	35	9.2
August	4	15.5

Evidence shows that sectional variations and habits of the Brown Thrasher probably exist. "The variations, believed to exist, relate in main to their choice of habitats, and nesting sites, . . ." (Sherman, 1912). In Massachusetts, this species often places its nests upon the ground or within 3 feet of that level; but in the western and southern portions of its range, this species seldom nests upon the ground (Bent, 1948). My data show that the nests of this species in the southern portion of the range are frequently more than 10 feet above the ground. Of the 108 nests, 30 were more than 10 feet above the ground.

Investigations that have been conducted on the nesting heights of certain North American species of birds indicate that the majority of these birds, especially those of eastern North America, nest at low elevations. Further investigations, however, on all species throughout individual species' ranges are necessary. Supplementary data from all sections of North America might reveal unknown nesting variations among certain species which might affect the overall height distribution of nesting birds. The author believes that more work needs to be conducted on the subject of the elevation of birds' nests with special emphasis on those species in the southern and western portions of the United States.

SUMMARY

An investigation on the elevations of birds' nests was conducted during the breeding season of 1963 in northern Louisiana, primarily on the campus and farm of the Louisiana Polytechnic Institute, Ruston. A total of 522 nests representing twenty-eight species of birds was found. The 522 nests ranged from 0 to 50 feet above the ground, with more than three-fourths of the 522 nests ranging from the 0 to 12.5 foot level. More than one-half of the 522 nests were below 7.5 feet from the ground. The mean height for the 522 nests was 9.1 feet from the ground.

ACKNOWLEDGMENTS

I am most grateful and indebted to my major professor and advisor, Dr. John W. Goertz for his guidance and helpful suggestions. Thanks are also given to the faculty members

Table 4

Mean Heights in Feet of 91 New Nests of *Toxostoma rufum* Found in the Given Months

Month	Number of nests	Mean height in feet
March	2	6.8
April	24	6.2
May	8	9.1
June	38	9.3
July	19	10.2

of the Zoology Department of the Louisiana Polytechnic Institute for suggestions during the writing of the thesis. The results reported here represent part of a thesis submitted in partial fulfillment of the requirements for the Master of Science at Louisiana Polytechnic Institute.

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THE WILLETS OF GEORGIA AND SOUTH CAROLINA

Ivan R. Tomkins

The New World genus *Catoptrophorus* has been placed between *Heteroscelus* and *Totanus* in the American Ornithologists' Union Check-list of North American Birds (1957). There is but a single species, divided into two subspecies, *semipalmatus* and *inornatus*. The current edition of the Check-list does not provide common names below the species level, but it is convenient, and should confuse no one, to continue to use the terms "Eastern Willet" for *C. s. semipalmatus* and "Western Willet" for *C. s. inornatus*, although the terms "coastal" and "inland" would be more appropriate.

Some confusion as to the status of the two forms on the western Gulf coast has existed in the past. Ridgway (1919) considered that the breeding form on the coast of Texas was *inornatus*, although he gave one breeding record for *semipalmatus* from Texas. Griscom and Crosby (1925:440, 531), aware of this confusion, collected breeding specimens from the vicinity of Brownsville, Texas, which Jonathan Dwight examined and identified as *semipalmatus*. However, they considered that the breeding birds from northeast Texas were probably of the western form. Subsequently, Bent (1929) concluded that all the coastal breeders were *semipalmatus* and that *inornatus* breeds only inland in the western states and the Canadian provinces. This view has been concurred in by others, and the ranges are so indicated in the 4th edition (1931) and the 5th edition (1957) of the A.O.U. Check-list. Ridgway's (1919) measurements and descriptions need to be revised to accord with this latter determination of the distribution of the two subspecies.

The ranges of these two subspecies as quoted from the current Check-list are:

C. s. semipalmatus—"*Breeds* in southwestern Nova Scotia (locally) and from southern New Jersey and Delaware south along the Atlantic coast to Florida; from extreme southern Texas (possibly Tamaulipas) eastward along the coast of Louisiana, the islands off southern Mississippi and Alabama, to the west coast of Florida; also locally in the West Indies (the Bahamas, Grand Cayman, Beata Island, St. Croix, Antigua).

Winters locally along the Gulf of Mexico coast (Tamaulipas, Texas, Louisiana, Florida), on the south Atlantic coast from Virginia to Florida, and in the West Indies (Bahamas, Greater Antilles); south to Central America (rarely on the Pacific side), Venezuela (Margarita Island), British Guiana, and northern Brasil (Pará).

Casual north to Newfoundland and Prince Edward Island."

C. s. inornatus—"*Breeds* locally from eastern Oregon, Idaho, central Alberta, southern Saskatchewan, and southern Manitoba south to northeastern California, western Nevada (Douglas County), central Utah, northern Colorado, western and northern Nebraska (rarely), and eastern South Dakota; formerly in western and southeastern Minnesota and Iowa. Recorded in summer south along the Pacific coast of México to Panamá and Ecuador.

Winters locally from northern California (Humboldt Bay) south to the Galápagos

Islands of northern Chile (Arica, Iquique); also from South Carolina to Florida, along the Gulf of México in Mississippi, Louisiana, Texas, and México, and around the Caribbean from Central America to northern Colombia.

Migrates in spring chiefly along the Pacific and Gulf coasts and through the interior; in fall, over the spring route but also spreading to the Atlantic coast."

Simply stated, typical *semipalmatus* breeds along the Gulf and temperate portions of the Atlantic coast of the United States, and *inornatus* is an inland breeder in at least eight western states, and three of the Canadian provinces. Both of these races have wide although interrupted ranges. Present knowledge gives little light on the migration orbits of the local populations, and their relationships. There has been no modern systematic study of the genus *Catoptrophorus*, as done by Pitelka (1950) for the genus *Limnodromus*.

The present work deals mostly with the breeding habits and habitats of Eastern Willets of the coast of South Sarolina and Georgia, but both subspecies must be considered, because both regularly occur in this region. The ranges as given in the Check-list are incorrect for this region, and need revision. The Eastern Willet arrives in late March, breeds and leaves in June and July. I have been unable to find any specimen from August to mid-March. Sprunt and Chamberlain (1949) state, as regards South Carolina "No winter specimens have actually been taken but this Eastern subspecies undoubtedly winters occasionally."—a rather ambiguous statement. Migration in any species of bird is seldom total, including all members of the population, and if an occasional Eastern Willet does remain in South Carolina over winter, the fact is of little moment to the population at large.

It may be that a critical study of the specimens from the Gulf coast will show that *semipalmatus* is not a common winter resident there since Burleigh (1944 and in litt., 1961) stated that he did not find a single individual during his eight winters on the coast of Mississippi. There are few such definitive accounts for most observers lump the subspecies together, even though they can be readily distinguished in the field.

The range of *inornatus*, as given in the Check-list, also needs to be revised, for this subspecies is present locally in Georgia and South Carolina in fair numbers all year long. I have collected about 40 specimens of both subspecies and in each case *inornatus* was in the gray plumage shown on Fig. 1, top. and not at all like the speckled *semipalmatus* (Fig. 1, center) or the juvenile of that form (Fig. 1, lower). The juvenile *semipalmatus* (Fig. 1, lower) was taken on 30 July. Its juvenile plumage, while not entirely grown, is sufficiently distinct to be obvious in the field. It would not have molted again before

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Fig. 1. (Top) *C. s. inornatus*, adult male, 21 March 1962 ("smoky-gray" plumage). (Center) *C. s. semipalmatus*, April 1962 (breeding plumage). (Lower) *C. s. semipalmatus*, female, 30 July 1962 (incomplete juvenal plumage).

leaving in the fall migration. I do not know what the plumage of the Eastern Willet after the postnuptial molt is like.

There are a few data suggesting that there are differences in timing of the breeding Willets of the south Atlantic coast. In the Savannah area the peak of the spring migration is in late March, and the nesting season from late April to June.

Stewart and Robbins (1958) give the peak of spring migration in Maryland as 25 April to 15 May, and the nesting season from mid-May to late July—a lag of about a month in 6 degrees of latitude, or about 360 miles.

The late D. J. Nicholson, the veteran oologist of Orlando, Fla., once asked me why he could find Willet nests at Matanzas Inlet (St. Augustine) in late March, while on Amelia Island (Fernandina) about 50 miles to the north, he could not find nests until late April.

These data are scant, but the inference is that there is some difference in the breeding schedule. Considering the relatively short season of gonadal sufficiency, I think of the possibility that these birds comprise different populations, in which free gene flow may be as effectively interrupted as by a mountain range, or any other natural barrier.

My acquaintance with the Willets began in the 1920's and has continued whenever possible ever since. The area most thoroughly covered is about the entrance to the Savannah River, with some time spent from the mouth of the St. Johns River in Florida, to Charleston, South Carolina. From 1959 through 1962 special attention was given to the breeding birds in the Savannah area. In 1959, the Willet nesting region was visited 50 times between mid-March and the end of June; in 1960, 30 visits were made; in 1961, 58 visits; and in 1962, 81 visits.

A previous paper (Tomkins, 1955) gave a résumé of the nesting schedule, and contained a graph showing the egg dates according to the experience of the late Gilbert R. Rossignol from 1907 to 1937, and my own data from 1923 on, a continuous record in the same locality for nearly 50 years. Later records show no significant changes.

Bent (1919) probably summarized most of the important information published before that date. One valuable paper has been published since on the Eastern Willet, but nothing extensive seems to have been published about the nesting behavior of the Western Willet. Vogt (1938) spent a few weeks with several pairs of breeding Willets at Fortesque, New Jersey, in 1936 and 1937. He was much interested in their behavior, particularly territoriality, according to the viewpoints then current in ornithological literature. He spent much time in a blind watching a few pairs, and he seems to have known little of the prenesting behavior. He did not stay until the young hatched. His birds ap-

parently fed and nested on the same territory. The birds I have known have a feeding range separate from the nesting location.

Nearly every account of this species, no matter how brief, mentions that it is a nondescript sandpiper-like bird until it lifts its wings and displays its white spaces. Vogt says, "this writer was first impelled to study the Willet through curiosity as to the biological significance of the Willet's striking wing pattern, which is invisible when the bird is at rest, and most striking when it is in flight. . . . Here, it seemed was a clear cut problem." His final conclusions only offer some suggestions as to its function as a Lorenzian "releaser," furnishing nothing new except that he did try to interpret the meaning of the white wing pattern, but reached no definite conclusion.

I, too, am unable to assign any unqualified purpose to the white in the wings, but will suggest some possible uses:

a. species recognition in mixed flocks of shorebirds,
b. the pattern may be stimulatory in courtship. The wings are extended and vibrated in precopulatory behavior, on the ground and in the air. This is also done during copulation.
c. distraction value when flushing from the nest.

But is it necessary for all such bright patterns—there are many among the shorebirds—to have absolute function and meaning? May not certain genetic changes, neither grossly favorable nor unfavorable, ride along, a package deal so to speak, with those of a more definitive effect?

MIGRATION

Our breeding Willets arrive quite regularly between 14 and 20 March. Both sexes arrive together. They seem to arrive in small groups, and the entire local population does not appear simultaneously. They seem to arrive at night. In the earlier years when my home was in Willet territory, I always heard them first in the middle of the night. In 1961 Dr. George W. Sciple saw the first groups of the season on the morning of 16 March, as he drove to work.

Eastern Willets passing to and from more northern breeding grounds. do not generally migrate through here either in spring or fall. An occasional flock has been seen to pass high overhead in spring, but these are rare. The flight ceiling of the local birds is 500 feet or less. If night migration is the general rule, it is possible that birds passing through would not be seen, but some flocks of birds resting on the beaches should have been found. I am inclined to postulate a migration route at sea.

Some of the early spring migrants are already separated from the main group into pairs, while others are actively seeking mates. Some pairs have been first found on the precise nesting territory of a previous year. Other small groups may be found on beaches which will not contain nesting territories.

The spring migration and the postbreeding migration (I dislike to call it "autumnal" migration because it takes place in late June and July) are in synchrony with the waxing and waning of the gonads. Specimens collected soon after arrival (with one exception) had no supply of fresh subcutaneous fat, merely a small supply of tough yellowish fat such as is found the year around. On the other hand, the birds of late June, while still behaving as though young were concealed nearby, had considerable accumulations of recent fat.

It is interesting to speculate on this matter of energy-producing fat. It is hard to believe that the precise amount of fat would be produced to bring the migrants to one locality with none left over. Does this mean, then, that the spring birds have a short migration, or one that is accomplished in short stages? Or does the postbreeding migration cover a much longer distance? And what determines that the egg-laying time is from late April to early June? The Eastern Willet, breeding from Nova Scotia to Tamaulipas and the West Indies, must encounter much greater extremes of temperature than are found in the Savannah area. Food is not a limiting factor, for the small crustaceans preferred by the Willets, are available here for at least 10 months of the year. It explains nothing to call it a "biological clock."

When our Eastern Willets arrive in spring, their slim testes are from 7.5 to 9 mm long. In late April and May they are 16 to 18 mm in length and about 13 mm in width. By late June, or soon after the hatching of the young, they have shrunk to 4 to 6 mm long, about the size in the winter season. They will then soon depart on the postbreeding migration. This short season of gonadal activity precludes the production of more than one brood of young—a common thing among scolopacine birds.

HABITAT

The salt marshes of the coast and the terrain around them furnish the chosen habitat of the Eastern Willet during its brief stay in spring and early summer. Now and then a pair will nest a little farther upriver where the marshes might be called brackish, but not frequently. For nearly 20 years I lived along the river, much of the time on floating dredges, etc. that covered the area well. I walked the beaches, waded in the marshes, and explored every creek, great and small, and never saw more than a half dozen pairs of Willets away from the saline region in that time. There were none in the extensive freshwater marshes.

It is not the lack of food that limits the range, for the species feeds largely upon the fiddler crabs of the genera *Uca* and *Sesarma*, and probably other crustaceans. *Uca minax* is abundant along all of the muddy riverbanks up to the edge of the river swamp at the inland edges of the freshwater marshes,

far beyond the range of the Willets. Nor does adequate nesting cover seem to be a limiting factor.

The salt marsh is a unique zone in many ways. Its vegetation is distinct, there are no amphibians, many of the birds are committed to life there, and there are many endemic invertebrates—crabs, shrimps, marine worms, etc. It is rich in species, some of them present in great numbers. Largely unspoiled by man, it is nearly a primitive wilderness. In the Savannah region the salt marsh covers a wider band than anywhere else on the southeastern coast of the United States, perhaps because of the tidal range, which averages 7.5 feet in the Savannah area, and is often much higher during the spring tides.

According to Oney (1954) the coastal region of Georgia contains about 308,177 acres of salt marsh, roughly 0.9 per cent of the area of the state. It is a guess, and only a guess, that the breeding Willet population is not greater than two or three pairs to the square mile of this area. Nothing offers a clue why geophysically similar freshwater areas of the East contain no breeding Willets (or any wintering ones) at all.

The dominant higher plant of the wet salt marsh is a cord grass, *Spartina alterniflora* which forms dense bands of vegetation from about mid-tide range up to the flatter "marsh table" where it blends into other vegetation. Below the *Spartina* belt the receding tides bare extensive mudflats, live oysterbeds, and sandbars. Much of this area is punctured thickly with the holes of fiddler crabs, burrowing shrimps, etc., greatly increasing the total exposed area and the retention of water, with a corresponding increase in animal life.

The feeding habitat of the Eastern Willet is here in the salt marshes, not in the dense vegetation but on the oysterbeds and mudflats, the sparsely vegetated marsh table above mid-tide, and around the edges of the marshes. Sometimes they feed on the beaches.

The nesting habitat is on slightly higher ground near the marsh or the beach, usually above the reach of the tides but vulnerable in times of extremely high tides.

The eastern end of U.S. Highway 80 is on Tybee Island, Chatham County, Ga., close to the Atlantic Ocean. The area I have worked most thoroughly in recent years, is along this highway from Tybee Island across Lazretto Creek and the salt marshes about 6½ miles to Bull River. I estimate about 100 pairs of Willets nest there. The population has been quite stable for many years. The main part of the Willet population is concentrated in the eastern 2½ miles with the rest thinly scattered over the remainder. They nest along the sides of the road (even with much automobile traffic passing within a few feet), on parts of an old railway bed, and on some sand and shell banks from road construction. The nesting grounds and the feeding grounds are in general separate. Some food is picked up near the nest sites, but not the major part.

VOICE

The voices of our breeding Willets are loud and strident, and may be heard long before the bird comes in sight. They are full of small nuances, seemingly dependent on the nervous excitement of the bird at the time. Most of the calls fall into three categories to which some semblance of use can be assigned. The best known is the *Pill-will-willet* call which gives the bird its name. It is sometimes given in two syllables, usually in three, sometimes in four. It seems to be connected with territory, *i.e.*, the presence of the mate, whether on nesting territory or elsewhere. Often it is a challenge to another male. It is usually used by the male, although Vogt (1938) reports it as sometimes given by the female. This call is heard commonly day and night during pair formation, somewhat less so during incubation, and occasionally while escorting young in the marsh. I have never heard the Western Willet give this call in this locality. Dawson (1923) writes of the migrating Western Willets in California, "I have besought these passing birds a hundred times to say *willet*, but they have refused." However, Bent (1907) describes the nesting of the western subspecies in southwestern Saskatchewan, and clearly tells that their notes sounded "like *pill-will-willet*," and Taverner (*in* Roberts, 1932) recognized the call on the breeding grounds in the west.

The second call, a sharp *Kleep* or *Klip* is an alarm call that both sexes repeat incessantly when any intruder nears their territory. It varies in intensity and rapidity. Sometimes when an incubating bird flushes, this call approaches a scream.

The third recognizable call, a plaintive *Phwee-hoo*, rising on the first part, falling on the second, appears to be a summons from one of a pair to the other. One bird may alight on a pole or wire, call quietly or loudly, and the mate soon appears.

When the newly hatched young are separated in the grass, they have a thin wiry call which cannot be heard very far. It presumably serves to keep the family together and to inform the adults of the location of the young. It is only heard at that time, and if the young birds when a little older have any other call, it has not been recognized. More fieldwork could profitably be done on this matter.

PRENESTING BEHAVIOR

For about three weeks or more after arrival, and before egg-laying the Willets gather in flocks in open places in the marsh and engage in courtship behavior. I have been unable to determine just what sets off these gatherings or ends them. A flock will be noisy and active in one place and then begin to leave, only to settle down in an equivalent place somewhere else. Even though many are paired upon arrival, and though some pairs go at once to a location where there has been a nest in other years, still at times they join

the courting flock. Although this species comes under the influence of the tidal rhythm—as much of the feeding is done on the low tides, and the birds must withdraw from the marshes when they are covered with water—these gatherings are not entirely correlated with the tides, and the groups gather at various times, even after some eggs are laid. At such times the nesting territories are vacant. These social gatherings may be desirable to stimulate physical and psychological conditioning for successful nesting. There is some similarity to the "leks" used in communal courtship by the Ruff (*Philomachus pugnax*), the American Woodcock (*Philohela minor*), and certain grouse, among others.

Two opposing tendencies seem to be in dynamic balance: (1) the flocking or gregarious tendency, effective all year long is centripetal; (2) there is the territorial spacing, which is in general centrifugal. Similar tendencies, in apposition, may be found in many species, particularly the water birds.

It follows naturally that the Eastern Willets select nesting sites around the periphery of the courtship area, which is itself unsatisfactory for nesting. This logically brings up the hypothesis that the breeding population of Willets is not evenly spread over the available nesting habitat, but consists of a series of flock groupings, centered on particular courtship areas, leaving vacant or thinly populated habitat. My field experience indicates that this does occur. It would be more readily noticed with a scant population, and less so where the population more nearly filled the available habitat.

The earliest arrivals in spring often appear to be paired, staying together or flying off together. There are also triangles, two males competing for the attention of one female. On one occasion, 3 days after the first spring arrivals were seen, two birds made a number of circuituous flights, coming back each time to land on one spot of suitable nesting terrain. Each time they landed the male attempted copulation. This male which was collected had testes slim and about two-thirds maximum length. During the prenesting period many courtship flights take place. Some of these are bisexual, others clearly competition between males. The frequency of these male bouts and their continuation for several weeks, suggests a slight excess of males in this local population. In no case, however, have three birds been found in amicable association on the nesting grounds. On the communal courtship-feeding grounds the scene is too confused for interpretation. It may be that an excess of males furnishes a social stimulus which leads to satisfactory nesting.

Competition between males may come to actual combat on the ground. Two birds will spar at each other much as young roosters do, and one may grab the other by the mandibles close to the head and throw it down. The female takes no part, but will often squat on the ground, perhaps a sign of readiness to mate. A pair may be standing quietly near the nesting territory. A male *pill-*

willets not far away, and the resident male immediately answers in kind and takes flight to give chase, while the female may or may not squat for a moment. The two males circle around, *pill-willeting* incessantly until the intruder leaves. Later in the season, when several pairs with nests nearby have been protesting my presence. if one male *pill-willets* it gets a quick response from another with perhaps a short chase on foot, but combats are rare then. The birds are monogamous and usually stay together. If either one flushes from the nest, the mate soon appears and both *kleep* loud and long.

Vogt tried to distinguish the sexes by size, but finally had to depend on behavior. He only collected one bird. From the weights and measurements of about a dozen breeding birds I have collected here, it is clear that the female is slightly larger on the average, but the sizes overlap so much that the only criterion in the field is the behavior.

In precopulatory display on the ground, the male standing behind the female lifts and extends his wings and vibrates them through a very short arc, conspicuously displaying the white in them. He also does this during copulation. A similar display is seen when two competing males in flight shorten the wing arc and vibrate the wings rapidly. This is probably the behavior called "Spottying" by Vogt, because he saw a resemblance to the flight of the Spotted Sandpiper (*Actitis macularia*). The designation does not seem particularly apt to me, because the scaling flight of the Spotted Sandpiper is intermittent, while that of the Willet is continuous. I prefer to use the term "Wing-waving." On the ground the arc of wing movement is so short that there is no lifting effect. In the air, either in forward motion or hovering the arc is somewhat greater. In the air the performance blends into and out of the normal flight. On the ground the Wing-waving is not easily confused with any other performance.

TERRITORIALITY AND NEST SITE DEFENSE

To the male, territory has three aspects:

a. In the prenesting time and perhaps later, territory is where the female is, whether on the nesting site, or out in the wetter marsh area. He defends it physically against other males, and by clamor against other intruders.
b. During incubation, it is also where the female is—on the nesting grounds.
c. In postnesting time, it is with the young that are hiding in the marsh, although this is somewhat of a flock reaction.

The female appears to share in the latter two situations and perhaps also in the first.

If one goes into an area with numerous Willet nests, he is attended by protesting birds all through it. By marking some of the birds, it was found that each pair would follow an intruder only a hundred yards or so, and was then replaced by another pair. There is no actual defense of the nest, as far

as I could see, just a lot of clamor. The old Negro saying is applicable, "He fight wit he mout." Toward other species of birds there seems to be no animosity. Gull, tern, Dunlin. plover, all are simply ignored. Wilson's Plovers and Least Terns, as well as some passerines, nest only a little way off, but they are not pursued or troubled. In this particular area there are no hawks during the nesting season, and behavior toward raccoon, feral dogs, and cats, was not observed. When a Willet stalks through the tern territory it is dive-bombed by these pugnacious sprites, but the Willet simply bobs its head and goes on. Rarely, a Willet in the vicinity of nest or young, will walk around with drooping wings, perhaps coming back toward the intruder. This has some vague resemblance to a distraction-display ("Injury-feigning," "Cripple-display") but it would be a rash observer who would so name it.

The parental pair-bond appears to dissolve about the time the young birds are developing in the marsh, and the "mobbing" of an intruder takes on the character of a group activity. It is not unusual to find 20 or 30 birds over one marsh area, loudly protesting, then to return an hour later and find a similar group very noisy elsewhere.

NESTING SITE

Because the male follows the female, often with spread tail showing much white, in the prenesting days, it is logical to assume that the female chooses the nest site. There is no scrape-making as in the Wilson's Plover (*Charadrius wilsonia*) (Tomkins, 1944), where the male selects possible nest sites and makes scrapes, to be followed by the female who finally selects one. This is unlike some of the passerines, the Mockingbird (*Mimus polyglottos*), some of the icterids, etc., wherein the male arrives first, establishes territory, and accepts whichever female comes along.

The nests are made on the ground. Many are well concealed in short thick grass, others are partly concealed, while now and then a nest is placed out on the open sand or the dead oystershells with as little concealment as that of a Least Tern. A nest on oystershells is concealed by the "disruptive pattern." Those on open sand are not so protected. There is no indication that one is chosen over the other. Generally all of the sites are within commuting distance of the salt marsh where most of the food is obtained.

The nests are simply constructed, mostly of grass stems bent down to make a thin floor (Fig. 2). One nest on open shells had a well-built rim of dead grasses that must have been brought at least 100 yards, but another not far away had no foreign material at all. At old Fort Pulaski, on Cockspur Island. one nest was placed in the grassy lawn, an area of about 4 acres, completely surrounded by the high brick walls of the fort. The only egress on foot is through the arched sallyport, with gates that are closed at night, and with

numerous human beings passing through at all hours the fort is open. One nest on Turtle Island, South Carolina, was on a dense floor of drift sedge, with a few inches of water underneath.

Many nests are so near the high water mark that an abnormally high tide will flood them out. Fortunately, storm tides are rather rare during the nesting season. It is not uncommon to find the bottom of the nest wet, either from rainwater or tidal water. One bird was flushed from a full clutch of eggs in one of the normal heavy showers of summer, and the eggs were found to be in water an inch deep. The birds continued to incubate these eggs for a few days after the rain, but the nest was later abandoned.

Normally Willet nests are at least 200 feet apart, although I once found two nests with a paced interval of 42 feet. One of these nests was an early one and the other much later, which may explain the tolerance of the owners. Intervening shrubbery 3 or 4 feet high may reduce the horizontal spacing to some degree. Nests are not usually placed in thick shrubbery or in any location where the birds cannot fly in and out.

EGG LAYING AND INCUBATION

The Willet is a determinate layer (as are most of the Charadriiformes as far as is known). It lays a certain number of eggs and no more, even if some of the earlier ones are removed. It follows that some mechanism probably limits egg production, but what or how is unknown. The infrequent sets of three may be caused by the loss of one of the normal clutch, perhaps to a predator, or by one of the eggs being laid adventitiously elsewhere than in the nest. I once found such an egg, still moist, and laid without vestige of a nest, and seemingly never returned to.

Alexander Sprunt, Jr., in a letter to Vogt told of more than one female using a nest, and of finding as many as eight eggs in one nest. He did not elaborate on his reasons for the belief that this was the work of more than one female. This must be a rare occurrence. I have been finding Willet nests since 1923, and have never found more than four eggs in any nest. The late Gilbert R. Rossignol, an active oologist from 1907 to 1937 found only two sets of five in that time. Rossignol wrote Arthur T. Wayne of finding a set of five, and received the following answer, dated 31 May 1916, "I have no doubt at all that the set of n/5 Willet you took were *all* laid by the *same* bird. But *five* eggs are very rare and I have taken five only twice."

The eggs are laid at intervals of 1, 2, 3, or even 4 days. Eggs may be laid in the forenoon or in the afternoon, perhaps even at night. A set of fresh eggs weighed 157.2 grams, and the average weight of three summer females was 242 grams. So the female produces about 65% of her own weight in eggs in a relatively short time. The eggs are large and four are about all that a

FIG. 2. (UPPER LEFT) Typical concealed nest. (UPPER RIGHT) Atypical nest, not concealed. (LOWER LEFT) Newly hatched young, with eggshell, showing the characteristic breakage of normal hatching. (LOWER RIGHT) Young Willet, about 2 days old. The plover-like bill and the down pattern, characters which may not be evident in dried specimens may be seen clearly.

bird can cover. Both birds are known to share in the incubation duties and neither has a vascular brood patch. One nest contained two eggs of Wilson's Plover in addition to a full clutch of Willet eggs. After some of the Willet eggs hatched, and the birds abandoned the nest, I opened the plover eggs and found that they contained nearly full-term embryos.

In only one case have I known of eggs being laid in the same nest, following destruction of the first set. This nest had a full clutch of four which were destroyed by a mower after the clutch had been completed at least 11 days. Eight days later there was one egg in the nest, and 3 days after that (or 11 days after the first set was destroyed) there were four eggs. The nest was not followed through to hatching. In another case, three eggs disappeared one night, and the fourth on the following night. About 3 days after the eggs disappeared the male of this nest (who had been marked by putting paint pigment on the grasses that hung over the nest) was seen copulating with another bird nearby, and it was seen in the locality for several days afterward, but did not stay long enough for a new set of eggs to be hatched. The

place was searched carefully, but no second nest was found, and the old one was not used.

According to general understanding, the incubation period is "the elapsed time between the laying of the last egg in a clutch and the hatching of that egg when all hatch" (Nice, 1945). In an earlier account (Tomkins, 1932) I reported the incubation period as 24–25 days, based on only one clutch. Subsequent observations have shown from 22 (possibly 21) to 29 days. The reason for this variation is not at all clear. It is generally thought to be a matter of varying parental attentiveness, but there is some evidence of another reason. In several instances I have found that the adults have left the nest after one or two chicks hatched, and upon opening the remaining unhatched eggs, I found that the embryos were in different stages of development, indicating the possibility that incubation was started before the clutch was complete.

One clutch of Willet eggs was weighed in the field, 13 times, from completion of the clutch until they hatched 29 days later. The accuracy of the weights was not particularly good, due to the constant breeze in the field, but at the start the average weight per egg was 39.2 grams, and when near hatching 34.7 (a loss of 4.5 grams). A single newly hatched chick from another nest weighed 22.5 grams. This chick had been hatched long enough to dry off.

THE YOUNG

The eggs may hatch in the morning, afternoon, or perhaps at night. It takes about 2 days for the chicks to break through the shell, and the opening is consistently on one side toward the larger end (Fig. 2 lower left). The parents remove the eggshells from the nest, sometimes only a few feet, often to some distance. As soon as a fairly large hole is made, the chick begins to breathe atmospheric air, and its breathing can readily be seen. It has a shell-breaker ("egg-tooth") on *both the upper and lower mandibles*, but these are shed very soon. One chick although still wet had struggled out into the vegetation on my coming. As I put it back in the nest with the rest of the brood for photographing, the shell-breaker came off and was lost in the oystershells, but the scar was still visible. At hatching the chicks seem to have considerable vision, and are homoiothermal to quite a degree. The mild climate may be of assistance in this matter. They are well covered with down, which is buffy in some, but plain gray in others. They are quadrupedal at first but soon develop strength in the legs and can stand up and run. At hatching, two young birds had tarsi 30 mm long, about 50 per cent that of the adults. The legs are quite necessary to their sojourn in the marsh, and develop faster than the wings. Another young bird, perhaps a week old, had tarsi 47 mm long. Within a couple of hours (in the daytime at least) after drying off, they leave the nest and it has no meaning to either young or old after that. There is no evidence

that they are ever fed or brooded by the parents. It has been impossible to determine much about the possibility that the young birds are brooded at night, or in cold weather. I wonder how the young birds are cared for in the colder climate of Nova Scotia.

An important bit of Willet behavior that may have been overlooked for some time was first noticed in 1959, and later observations indicate that it is of regular occurrence. If all the eggs do not hatch at the same time, the first young birds leave the nest, and the parents go with them abandoning the rest of the eggs, which would hatch within a day or so. In 1960, I ran an experiment with four nests, using two for each test. Nest A was a few days earlier than nest B. The eggs had been numbered as soon as they were found. Two eggs from nest A were traded with two eggs from nest B. In each case the adults left with the first young to hatch. I opened the other eggs and found well-developed embryos in each.

There is no question that this trait may seriously affect the nesting success, and the replacement rate. I can see no way that interference of any kind has caused this to happen. In an altricial species, where the young are cared for in the nest, the effect may be negligible.

The adult Willets attempt to get the young into a nearby marsh as soon as possible. Mrs. Alva Hines of Hiltonhead Island near the outer beach has a shop near a tongue of *Spartina* marsh that reaches into the island. In 1961 she saw adult Willets escorting young birds straight down the hard road past her shop and into the marsh. Whenever a car came down the road, the young Willets would hide, resuming their trek when all was clear. In 1963, I saw much the same thing, with one young bird moving across a four-lane road from the nesting area on an old railway bed, to the marsh across the road. The adults shrieked and flew back and forth, but the young bird apparently moved under its own volition, for there was no sense of guidance in the frantic calls and flights of the parents.

The young birds may be seen now and then, but they are furtive and rail-like in behavior until they reach the flight stage. The adults leave the region before the young are able to go with them, and I do not know much about the autumnal migration. Two young birds, able to fly but without fully grown primaries could usually be found in a particular isolated marsh. If disturbed they would fly away a quarter mile into the larger marsh. If I came back an hour later, they would be found again in the home marsh.

POPULATION AND NESTING SUCCESS

In the region I have described the Willet population has been stable for many years. There has been some shifting of populations, following the disturbance of road building, or the growth of vegetation, but it has taken place slowly and has not hampered the species to any noticeable degree.

In the 1961 season, 19 nests were found, marked, and visited as often as possible. The nesting success was of a low order but exact data cannot be furnished, because it was not certain just what had happened to some of the nests. In 1962 a smaller area was worked more carefully. Sixteen nests were located and definite data obtained concerning them. The 16 nests contained 56 eggs—they would have contained 64 eggs with full clutches. Two nests were abandoned with eggs in them; seven eggs were left unhatched in the nests; in some cases the eggs simply disappeared; and it is believed that 11 young birds hatched and left the nests. To maintain its numbers the local Willets would need to have a long reproductive life if this success is typical.

Some of the egg loss may have been from predators. Several eggshells in early to middle incubation stages were found on the mudflats, punctured by some avian predator. One nest was probably broken up by a raccoon. Another nest was hatching one afternoon but the next morning it contained only the legs of two young Willets. A few feet away on the mud were the fresh tracks of a raccoon and an otter. One cloudy morning a gray rat snake (*Elaphe obsoleta quadrivittata*) was caught in the act of trying to swallow a Willet egg. This and other species of snakes, as well as raccoon, otter, and mink are all common in the area.

FOOD

The food of the Eastern Willet consists largely of the small crabs that are so abundant in the salt marsh. About a dozen stomachs have been examined, without attempting to make a detailed analysis, and all contained many chitinous fragments, mostly of the genera *Uca* and *Sesarma*. Three species of *Uca* (*minax*, *pugnax*, and *pugilator*), and two species of *Sesarma* (*cinerea* and *reticulatum*) abound in the area, as well as many other small crabs. One bird killed on the road contained the torso of *Sesarma reticulatum*. In the field the birds have been seen to eat some species of *Uca* frequently, sometimes not far from the nest. One bird regurgitated a pellet, about 8 mm in diameter which was round, firm, and was composed of chitinous fragments. No sand has been found in any stomach. Some Willets will feed along an outer beach, where no marsh crabs occur. None of these has been collected and what they feed on there is unknown. A young Willet, perhaps a week old, had a small gastropod, probably *Littorina irrorata*, in its stomach. This snail is abundant in the salt marsh, as are many other species.

SUMMARY

The ecology and some of the ethological traits of the breeding Eastern Willets in the vicinity of Savannah, Georgia, has been under observation for some years, and are recorded in some detail.

Minor mention is made of the occurrence of the nonbreeding Western Willets in the same locality.

ACKNOWLEDGMENTS

Dr. Oliver L. Austin, Jr., edited a previous draft of this paper, making many worthwhile recommendations. A still earlier draft was critically read by Miss Clermont Lee. My thanks are due to both.

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1231 EAST 50TH ST., SAVANNAH, GEORGIA, 18 APRIL 1964

EFFECTS OF A LOW-LEVEL DIELDRIN APPLICATION ON A RED-WINGED BLACKBIRD POPULATION

Richard R. Graber, Steven L. Wunderle, and Willis N. Bruce

In May 1964, an irruption of army worms (*Pseudaletia unipuncta*) was detected in wheat and barley fields of southern and central Illinois. Through news media, entomologists in the state recommended that heavy infestations of the worms be treated with dieldrin at the rate of one-eighth to one-fourth pound per acre, but cautioned that insecticides should *not* be used unless the number of worms was at least six per linear foot of drill row. Many farmers in Illinois contracted to have their small-grain fields sprayed. Among the fields treated were several on a pheasant research area near Neoga, Cumberland County, Illinois. Between 25 and 27 May, about 1,000 acres in the Neoga area were sprayed by airplane; the spray was formulated from dieldrin emulsion concentrate in water, and the rate of application was one-fourth pound of the active insecticide per acre.

Because Scott et al. (1959:426) had observed heavy mortality of birds in Illinois. resulting from agricultural applications of dieldrin at the rate of 3 pounds per acre, we were interested in learning whether applications in relatively low concentrations would have any notable effect on a local bird population.

We had no opportunity to plan the study prior to the dieldrin application, for spraying was already under way in the area on 25 May, when we learned about it. Fortunately, Wunderle had taken an interest in the local Red-winged Blackbird (*Agelaius phoeniceus*) populations in the course of his spring field studies on pheasants in the Neoga area. He was doing fieldwork in the area when the spraying operation began and made some observations on the behavior of redwings while the fields were being sprayed.

Only wheat was intentionally treated, but fields adjacent to the treated wheat fields probably received some spray from drift due to wind. Wheat fields in Illinois support very low populations of nesting birds (Graber and Graber, 1963:408), but many of the wheat fields in the area were next to hayfields which supported very dense bird populations (op. cit., 416). Thus, we chose for study a 10-acre hayfield located next to a sprayed 20-acre wheat field. On 25 May, the date the wheat was sprayed, wind was light (10 knots or less) from the southwest. Our hayfield study area was immediately north of the sprayed wheat and almost certainly received some drifting insecticide. This is the only sense in which the hayfield was "treated," but here after we shall refer to it as the treated field.

For purposes of comparison we selected another 10-acre hayfield in which to make observations on nesting success of redwings. This "control" field was

located 2 miles north–northeast of our treated field and 2 miles from the *nearest* known dieldrin-treated field.

Three species of birds, the Red-winged Blackbird, Eastern Meadowlark (*Sturnella magna*), and Dickcissel (*Spiza americana*) were common in the Neoga hayfields, but we concentrated our observations on redwings because their nests are easily found. We made observations, searched for nests, and collected specimens in the treated field on 25, 26 May and 1, 9, 15, 18, 22, and 29 June, and in the control field on the June dates. We located nests by systematically walking the fields. Coverage was fairly thorough, though we probably overlooked some nests.

Analysis of specimens was carried out by Bruce, Jeanne Wilson, and other staff of the Economic Entomology Laboratory of the Illinois Natural History Survey, using the extraction and cleanup method described below, and gas chromatography (Coulson et al., 1959:250). In the processing of specimens for analysis, 25–50 grams of tissue were cut from the bird body, blended in 10 per cent acetone in hexane, and extracted. The sample consisted mainly of muscle and bone, but included a small amount of feathers and tarsus. From one specimen, only the stomach contents and liver were analyzed. Otherwise, viscera were not included in the tissue analysis. Shells of egg specimens were not used, and the contents of four to six eggs (10–15 grams of tissue) were combined and processed as a single specimen. The extracts were digested in potassium hydroxide and ethanol, extracted with hexane and ether, and dried over sodium sulfate. Fats were saponified with potassium hydroxide, extracted and cleaned up on magnesium oxide and Florisil. Each specimen was analyzed on two different columns and two different gas chromatographs with electron capture apparatus. Separation of DDE and dieldrin was accomplished with a polar column (Shell Epon Resin 1001 on Chromosorb W.). Standards were analyzed with every set of samples, but determinations were not verified by any other method. As used, the method will detect a variety of chlorinated hydrocarbon and organophosphate insecticides. Because the laboratory had numerous other commitments, only a small number of bird specimens were analyzed. We undertook the work primarily as a pilot study to familiarize ourselves with the problems involved. The data proved interesting and we felt they should be placed on record.

As early as 27 April 1964, Wunderle and Graber had observed redwings building nests in the vicinity of Neoga. The females that were building, however, represented only a small part of the total redwing population in the area. So far as we could determine, nests were being constructed only where there were good stands of cattails (*Typha*) or in woody cover, particularly young stands of willow (*Salix*). Redwings of both sexes were also present in hayfields, but their behavior was not that of birds with nests, and though we searched at least three fields, we found no nests. Presumably the hay plants were still too low or sparse for suitable nesting cover. Subsequent observations indicated that a small number of redwings began nesting in the hayfields in early May, whereas the bulk of the population did not begin nesting until mid-May or later. These observations were made within a few miles of the fields that we later chose to study, but no observations were made at the treated field

TABLE 1

INSECTICIDE RESIDUES IN EGGS AND YOUNG OF AGRICULTURE-ASSOCIATED RED-WINGED BLACKBIRDS COLLECTED NEAR NEOGA, ILLINOIS, JUNE 1964, FROM ONE DIELDRIN-TREATED FIELD AND ONE UNTREATED FIELD

Specimen	Age	Number of spec.	Time of Collection: Days after treatment	Field	Dieldrin (ppm)	DDE (ppm)	Remarks
Eggs	Fresh*	6 (from 6 nests)	7	Control	1.7	0.0	At least 50% hatch from these nests.
Eggs	Fresh	6 (from 6 nests)	15	Control	1.7	0.0	At least 50% hatch from these nests.
Eggs	Fresh	5 (from 5 nests)	15	Treated	5.7	0.0	All nests failed, apparently deserted.
Eggs	Fresh	6 (from 6 nests)	21	Treated	6.3	0.0	All nests failed, apparently deserted.
Eggs	Fresh	4 (from 4 nests)	28	Treated	0.2	0.0	Nests destroyed by harvest.
Juvenile	15 days	1	15	Treated	3.4	0.0	Appeared healthy.
Juvenile	Neonate	1	24	Control	0.2	0.2	Appeared healthy.
Juvenile	2 days	1	24	Control	0.0	0.0	Appeared healthy.
Juvenile	5 days	1	24	Control	0.1	0.1	Appeared healthy.
Juvenile	9 days	1	24	Control	0.1	0.1	Appeared healthy.
Juvenile	25 days	1	24	Control	0.3	0.2	Poor condition.

* Incubated no more than 1 day.

itself until 25 May when the dieldrin was applied. On both 25 and 26 May, Wunderle made observations on birds in the treated hayfield. There were at least 25 redwings in the field. Some of the birds actually flew into the adjacent wheat to forage as the spray was being applied, and birds at the south edge of the hayfield probably contacted drifting spray also. We do not know whether or not the redwings were feeding on army worms at this time. The stomach of an adult male collected 22 hours after the treatment contained no army worms but was packed with small dark beetles, probably curculionids from the hayfield. The stomach and liver of this redwing contained about three ppm of dieldrin and two ppm of DDE (a DDT metabolite). So far as we know, no DDT had been used recently in the immediate area, and the DDE residue is indicative of the omnipresence of DDT in the environment. Before the male was shot, his behavior seemed normal; he was aggressive, calling, and giving territorial displays. On 25–26 May, the treated population in general was active and normally aggressive, the birds giving alarm calls and making flight "attacks" on the observer. No nests were found in the hayfield at this time, though nests in the very early stages of construction could easily have been overlooked. We feel certain that at least one nest *was* overlooked, because 2 weeks later we found a stub-tailed juvenile (Table 1) which was

almost certainly hatched in the treated hayfield about the day of the spraying. The survival of this juvenile in apparent good health is somewhat puzzling in view of our subsequent observations.

The population and its behavior changed drastically by 1 June, when no more than 11 redwings were left in the field. The birds were quiescent; they made no attacks, and uttered no alarm calls. In a search of the field we found only five nests, all in the same half-finished stage of construction. The nests, which had been placed in the taller, more robust plants in the field, appeared to have been started about the day of the spraying or shortly after. At a more fragmentary stage they could have been overlooked on 25 May, and so it is possible they were *initiated* even before the spraying. (Allen, 1914:98, found that nest construction by redwings usually requires 6 days.) Subsequent observations showed that these nests were never completed. Redwings are extremely sensitive to intrusion during the nest-building period (Allen, 1914:98), and the nests we found may have been deserted because we walked near them. However, the obvious apathy of the population suggests that the nests had already been deserted when we found them. They were probably deserted after 26 May and before 1 June. This desertion, the marked population decline, and the change in behavior of the remnant population led us to conclude that at least some of the birds in the initial resident group were killed by the dieldrin spray. We found no dead redwings, but an emaciated adult male (testes much enlarged) meadowlark which we found dead in the same hayfield on 1 June contained 5.6 ppm of dieldrin. Whether or not this represents a lethal level is unknown. A road-killed meadowlark picked up outside (but near) the treated area the same day had only 0.2 ppm of dieldrin.

On 1 June we searched the control field for the first time and found seven nests. The number of nesting redwings was always higher in the control than in the treated field, but little weight can be attached to these population differences, because densities of bird populations in hayfields are highly variable from field to field (Graber and Graber, 1963:416). Though we may have overlooked some nests in the control field, the nests we found showed that the redwing tenants were all in about the same stage of the reproductive cycle; i.e., they were laying. The nests had incomplete clutches, and none of the eggs showed obvious signs of incubation (established by candling). Our data suggest that the nesting cycle was fairly well correlated between birds of the treated field and birds of the control field up until the time of the treatment. Thus, most of the females in the control field were just starting to lay eggs on 1 June, and, as near as we can judge from our incomplete data, this is probably the stage the treated birds would have reached in early June had they not deserted. (Egg-laying in the redwing usually follows immediately the completion of the nest, Allen, 1914:99.)

In the control field on 1 June, we collected one fresh egg from each of six nests. These eggs contained 1.7 ppm of dieldrin. On 9 June another sample of six fresh eggs (six nests) was collected from the control field and these also showed 1.7 ppm dieldrin (Table 1). Four of the nests from which we took eggs failed, either because of our interference or natural predation, but at least 50 per cent of the eggs in the remining nests hatched; we did not learn the fate of every egg, and hatching data are based on the presence of nestlings on subsequent dates. The source of the dieldrin in the control field is unknown. Territories of breeding redwings are not large (average: one-twelfth acre. Nero, 1956:149), and nesting birds probably do not fly 2 miles to forage. Whether or not wind drift could account for such broad distribution is also unknown, but, obviously, dieldrin was widely spread in the environment.

On 9 June we also searched the treated field again. Besides the unfinished, deserted nests which were still in place, we found nine new nests, four newly completed but empty, and five with fresh eggs. We collected one egg from each nest, and found that they contained 5.7 ppm of dieldrin (Table 1). On 15 June we found that all of these nests had failed. Though the cause of failure is unknown, our interference was probably a contributing factor. Besides the abandoned nests we found six new nests and collected one egg from each for analysis. They contained 6.3 ppm dieldrin (Table 1). Subsequent observations again showed that these nests failed to produce young. Between 25 May (date of spraying) and 22 June, so far as we could determine, redwings in the treated field hatched only one young, the fledgling which had hatched about the day of the spraying. When we found it, the juvenile was about 15 days old: it appeared healthy and flew well. When analyzed, its tissues were found to contain 3.4 ppm dieldrin. Redwings in the control field, on the other hand, produced many young (at least 43 nestlings and fledglings) by mid-June.

After 1 June we did not notice any marked change in the redwing population of the treated field, though the number of redwings in the control field increased steadily until, on 18 June, there were 23 nests, all simultaneously active. This influx may have occurred as a consequence of hay cutting in the area. which was steadily reducing the amount of available habitat for redwings. In the treated field, between 25 May and 15 June, there were three apparent "waves" of nesting attempts: (1) the initial five nests that were started about the date of treatment and subsequently deserted before completion. (2) the new nests of 9 June with eggs that contained 5.7 ppm dieldrin, and (3) the new nests of 15 June with eggs that contained 6.3 ppm dieldrin. How many different birds were involved in these nesting efforts we can only surmise. On the basis of population and behavioral changes we suspected that the initial group of nesting redwings either died or moved. The second and third groups of nests were so closely spaced in time (a maximum possible

interval of 6 days between nest failure and egg laying) that they almost certainly represented different birds. On 22 June we noted that there had been a marked increase in the redwing population of the treated field since the 15th, and in searching the field we found eight new nests in various stages of construction, four nearly completed. In addition, we found five new nests with eggs, and collected fresh eggs from four of them. These eggs, laid 28 days after the spraying, were nearly free of dieldrin (Table 1). The abrupt diminution of dieldrin residue in eggs between the 21st and 28th day after treatment is puzzling. Precipitation in the Neoga region increased after mid-June and may have had some effect on the distribution of dieldrin in the local environment. There may also have been an influx of birds from outside the spray area.

Juveniles from the control field had a low dieldrin content and showed little tendency to increase dieldrin content with age (Table 1). The presence of DDE in young redwings is interesting because the eggs were free of DDT or DDE contamination (Table 1). So far as we could learn, no widespread use of DDT occurred during the study. There are various possible explanations for the abrupt appearance of DDT in the young birds: drift from distant spraying, seasonal emergence of contaminated organisms from the soil, or a change in foraging habits of adult birds between the time the eggs were laid and the time they hatched.

Our data suggest that even low concentrations of dieldrin, widely spread, may have a notable effect on bird populations within the first 2 or 3 weeks after the application. Hatchable eggs with 1.7 ppm of dieldrin, and an active juvenile with 3.4 ppm, give some indication of the tolerance of redwings for the insecticide. In order to evaluate with any precision the ultimate effects of pesticides on bird populations, we need to know much more about both the environmental and biological distribution of these chemicals.

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NEW LIFE MEMBER

Mr. Fred T. Hall, a former Secretary of the Society, has recently become a Life Member of the Wilson Ornithological Society. Mr. Hall is Director of the Buffalo Museum of Science, Buffalo, New York, where he has made notable contributions to the fields of science education and conservation. His principal ornithological interests have been in making color movies of birds and in painting birds. The picture shows him beside his painting of the Cahow. In 1945 Mr. Hall was one of the discoverers of the still extant population of this supposedly extinct species.

Mr. Hall was educated at Wabash College, and Rochester Institute of Technology, and served as an officer in the U.S. Army. He is a member of the A.O.U., Buffalo Audubon Society, Genessee Ornithological Society (both of which he has served as president) and several museum associations. He is currently President of the Association of Science Museum Directors.

Mr. Hall is married and has five children.

LIPID DEPOSITION IN WINTERING AND PREMIGRATORY MYRTLE WARBLERS

Charles G. Yarbrough and David W. Johnston

For some time it has been known that many birds have characteristic lipid deposits associated with the time of migration (Wolfson, 1945, 1952; Odum, 1949; McGreal and Farner, 1956; King, Barker, and Farner, 1963), the lipid evidently supplying the energy required for a sustained flight. Odum and Perkinson (1951) considered lipid deposition to be a premigratory prerequisite, but, in spite of the fact that overseas migrants might have as much as 50 per cent of the body weight in lipids (Odum and Connell, 1956; Odum, Connell, and Stoddard, 1961), it is becoming increasingly evident that intracontinental migrants might be lean at the onset of migration (Hanson, 1962; Johnston, 1962; Nisbet, Drury, and Baird, 1963; Caldwell, Odum, and Marshall, 1963). The precise timing of premigratory lipid deposition is, therefore, being clarified at present, especially at it relates to *Zugunruhe* (King and Farner, 1963), hyperphagia (Odum and Major, 1956), and migratory pattern (Odum, Connell, and Stoddard, 1961). In the many investigations of lipid deposits in North American species (Odum, 1958; 1960*b*; Connell, Odum, and Kale, 1960; Farner, 1955; Wolfson, 1945; Helms and Drury, 1960), little attention has been given to either the correlation between natural food habits of the species and lipid deposition or to the qualitative nature of the lipids deposited (see recent work of Walker, 1964).

The present investigation is a report on the relationships among diet, lipids (quantitatively and qualitatively), and migratory patterns in the Myrtle Warbler (*Dendroica coronata*), especially on its wintering grounds in North Carolina. Its preferred diet of wax myrtle berries (*Myrica cerifera*) has been known for many years (Brewer, 1840), and in winter on the Coastal Plain of North Carolina this warbler reaches its peak of abundance in wax myrtle thickets (Pearson, Brimley, and Brimley, 1959). On the Piedmont Plateau of North Carolina Myrtle Warblers are frequently found associated with red cedars (*Juniperus virginiana*). Chamberlain (1961) noted that these birds are more plentiful along the coast in winter and that they disappear early in the spring from coastal localities. He suggested that the increase in Myrtle Warblers on the Piedmont in the spring is due to the arrival of birds from the Coastal Plain of the Carolinas, from farther south (Georgia and Florida), or both.

MATERIALS AND METHODS

Eighty-three Myrtle Warblers were collected in the winters of 1961–62 and 1962–63 from two localities in North Carolina: at Bladenboro (typical of

Table 1

Numbers of Specimens of Myrtle Warblers Collected in North Carolina

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Totals
Coastal Plain	3	4	8	6	4	2	6	—	33
Piedmont Plateau	4	4	4	4	4	4	6	20	50
	7	8	12	10	8	6	12	20	83

the Coastal Plain) and Winston-Salem (typical of the Piedmont Plateau). Table 1 shows the numbers of birds taken in each month for the two localities. In addition, 81 Myrtle Warblers killed at a Gulf Coast TV tower (Leon County, Florida) in 1960–61 were sent to us by H. L. Stoddard, Sr. and E. P. Odum.

Before lipids were extracted, each specimen was weighed, measured (wing chord, tail, bill), checked for molt, the sex and age determined, and the stomach contents removed. The lack of complete skull ossification was used to identify immature birds from October through December after which time ossification was generally complete in all birds. In this paper data for adults and known immatures are combined. Sex was determined by plumage differences, wing length (Tables 2 and 3), and examination of the gonads. Wing length alone proved to be reliable in distinguishing the sexes except in birds whose wings were 70 or 71 mm.

Stomach contents were stored in 70 per cent alcohol for subsequent examination. Food in the stomach did not greatly affect body weight, as might be true of some larger birds whose stomach capacities are considerably greater than those of this small bird. The empty stomach was put back into the body cavity to be extracted along with the rest of the bird. This technique has not previously been employed by others in extracting lipids. Stomach contents were placed in a watch glass and examined under a dissecting microscope. Plant materials (seeds or fruits) were identified to genus and species, animal materials (arthropods) only to order, due to their macerated condition. The per cent of plant and animal matter in each stomach was estimated on the basis of mass. These stomach contents were then dried in an oven (70 C) and weighed.

In the lipid extraction process, the technique employed by Odum (1958), and modified by Johnston (1962), was used. Briefly, the process involved dehydration of the opened, whole bird, grinding the bird in a blendor, lipid extraction with alcohol and ether solvents, and drying and weighing the lipid-free, dehydrated mass of bones, feathers, etc. Thus, for each bird we obtained three values: water weight, lipid-free dry weight, and, by subtraction, lipid weight.

TABLE 2

MEASUREMENTS OF SELECTED SPECIMENS OF MYRTLE WARBLERS

	McGregor*			Museum of Vertebrate Zoology	
	No.	Wing	Tail	No.	Wing	Tail
Males						
California (*hooveri*)	7	76.7** (75.7–78.0)	58.4 (56.4–60.5)	8	72.6 (69.6–75.1)	54.0 (50.3–56.8)
Eastern (*coronata*)	8	72.9 (71.1–74.4)	54.9 (52.8–57.4)	8	72.6 (69.7–77.0)	52.3 (48.3–55.0)
Females						
California (*hooveri*)	10	72.9 (70.4–75.2)	56.4 (54.1–57.9)	7	71.1 (70.0–73.6)	53.5 (50.9–56.3)
Eastern (*coronata*)	10	68.6 (67.6–76.7)	53.3 (51.3–55.4)	7	68.7 (65.5–71.4)	50.7 (48.5–53.3)

* Data computed from McGregor, 1899:33.
** Average and extremes in millimeters.

The total lipid fraction of three representative birds were each subjected to an assay to determine the weight of sterols, glycerides, and phospholipids per bird. This was an exploratory study carried out to give some indication of the relationships of these three lipid fractions in wintering and premigratory birds. Two "premigratory" birds were selected from groups taken just prior to migration, one from the Coastal Plain (21 April 1962) and one from the Piedmont Plateau (14 May 1962). The analytical methods utilized here followed the procedures for (1) sterols outlined by Zak (1957), (2) glycerides by Lambert and Neish (1950), Van Handel and Zilversmit (1957), Van Handel (1961), and (3) phospholipids by Stewart and Hendry (1935) and Fiske and Subbarow (1925).

SUBSPECIES OF THE MYRTLE WARBLER

Currently the A.O.U. Check-list (1957) recognizes two subspecies of *Dendroica coronata*—an eastern form, *D. c. coronata* (Linnaeus) and a western one, *D. c. hooveri* McGregor. Since *hooveri* has been reported rarely from Georgia (Burleigh, 1958) and South Carolina (Sprunt and Chamberlain, 1949), we thought it advisable to look for this subspecies among our North Carolina and Florida birds.

McGregor (1899) described *hooveri* as differing from *coronata* on the basis of a longer wing and tail in the former, with no mention being made of

TABLE 3

MEASUREMENTS OF MYRTLE WARBLERS FROM NORTH CAROLINA AND FLORIDA

	Wing		Tail		Bill (culmen)		Bill (nostril)	
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD
Males	90	73.6 ± 2.6 (68.2 – 80.9)	90	53.9 ± 0.8 (48.3 – 61.1)	88	9.41 ± 0.69 (8.2 – 12.0)	87	7.01 ± 0.92 (6.4 – 7.8)
Females	74	69.2 ± 1.6 (66.0 – 73.3)	73	50.7 ± 0.8 (46.8 – 56.9)	71	9.22 ± 0.42 (8.3 – 10.8)	72	6.84 ± 0.36 (6.4 – 7.4)

color differences. If his data are averaged, the measurements of *hooveri* and *coronata* appear as in Table 2. Subsequently, small series of both subspecies were borrowed from the Museum of Vertebrate Zoology and were likewise measured. These measurements also appear in Table 2 and do not show, as did McGregor's, a significant difference between the two subspecies in either wing or tail length, except possibly in females. Color comparisons of these two subspecies likewise failed to reveal reliable differences, even though Sprunt and Chamberlain (1949:455) have stated that *hooveri* is "decidedly larger, the male with black of breast more extensive and often of a more solid color" when compared with *coronata*. *Hooveri* was not originally described on any color differences, and the color differences reported by Sprunt and Chamberlain could be attributed to seasonal differences between the sexes and/or progression of the prenuptial molt. In the present study no reliable color differences ascribable to subspecific variation were detected. Therefore, since this study was not intended to be a detailed taxonomic one and since these preliminary examinations of specimens failed to indicate reliable differences in the two subspecies, no attempt was made to identify subspecifically the specimens utilized for lipid extractions.

Measurements from the 164 North Carolina and Florida birds (Table 3) correspond more closely to McGregor's concept of *D. c. coronata* than they do to *hooveri*, although there are 34 individuals that have wing lengths above the minimum established for *hooveri* by McGregor.

STOMACH CONTENTS

Identifications of fruits and seeds in stomachs were facilitated by use of comparative illustrations in Martin and Barkley (1961). Most of this vegetable matter was entire. On the other hand, the macerated and fragmentary animal contents were identifiable, usually, only to order by using Borror and DeLong (1960) and Jaques (1947). Weight comparisons of the stomach contents are included, but obviously the amount of food in the stomach varies with the time of day when the bird was taken, the availability of food, and

TABLE 4

STOMACH CONTENTS OF MYRTLE WARBLERS

	Wintering birds			Premigratory birds		
	No.	Mean ± SD	Range	No.	Mean ± SD	Range
Coastal Plain*						
Weight of stomach contents in grams	25	0.08 ± 0.05	0.01–0.18	8	0.04	0.01–0.13
Vegetable matter in per cent	25	78.0 ± 2.4	20–100	8	0	
Animal matter in per cent	25	22.0 ± 2.4	0–80	8	100	
Piedmont Plateau**						
Weight of stomach contents in grams	28	0.07 ± 0.03	0.02–0.13	21	0.04 ± 0.02	0.01–0.12
Vegetable matter in per cent	28	51.1 ± 2.6	0–95	21	0	
Animal matter in per cent	28	48.9 ± 2.6	5–100	21	100	

* Wintering = Oct.–Feb.; premigratory = Mar.–Apr.
** Wintering = Oct.–Apr.; premigratory = late Apr.–May.

other factors. Another interesting point is that the stomachs of all 81 of the Florida Gulf Coast birds were completely empty. These Florida birds were killed during night flights, at which time it is probable that digestive processes are at a minimum; whatever food might have been in their stomachs prior to the flight had already been rapidly digested. In their more extensive studies of migrating birds at this Florida site, Odum and his co-workers have found that most migrants have empty stomachs.

In general, the results of these stomach analyses (Table 4) agree with information on food habits of the species given by Bent (1953), but differ significantly from the report of Martin, Zim, and Nelson (1961). Bent gives qualitative information regarding the wax myrtle and red cedar in the diet. According to Martin, Zim, and Nelson 17 per cent of the food in winter was plant material, but our data show plant material to be more abundant at this season.

In stomachs from wintering birds on the Coastal Plain, an average of 78.0 per cent was vegetable matter, this being almost entirely wax myrtle berries. In fact, out of the 25 stomachs examined, 22 contained only these berries. The other three stomachs contained only berries of red cedar and poison ivy (*Rhus radicans*). These wintering birds' stomachs contained, on the average, 22.0 per cent animal matter with the orders Hymenoptera, Coleoptera, Dip-

TABLE 5

PROGRESS OF PRENUPTIAL MOLT IN MYRTLE WARBLERS

	No.	Coastal Plain	No.	Piedmont Plateau
1 Mar.–14 Mar.	2	None	3	None
15 Mar.–31 Mar.	2	Medium	3	None
1 Apr.–15 Apr.	3	Heavy	5	Medium
16 Apr.– 1 May	3	1 None; 2 Medium	6	Medium
2 May– 9 May	–		8	Heavy
10 May–17 May	–		7	4 None; 3 Light

tera, Hemiptera, and Lepidoptera (larvae) being the most common types. There were some arachnids and Homoptera, although these were not common. The average dry weight of the stomach contents in winter was 0.08 gram. This was the heaviest weight at any season, and is likely correlated with the greater per cent of vegetable matter in the stomachs.

In the winter birds from the Piedmont, plant matter comprised, on the average, only 51.1 per cent. The only type of seed or fruit found in the stomachs of these birds was that of the red cedar. Animal matter averaged 48.9 per cent of the stomach contents (principally Hymenoptera, Coleoptera, Diptera, Hemiptera, and larval Lepidoptera). Concomitant with the decrease in plant matter was a decrease in the average weight of the stomach contents to 0.07 gram. Thus the birds in the Piedmont have a diet that includes a much higher percentage of arthropods than birds from the Coastal Plain, during the winter months.

The higher percentage of plant matter eaten by the Coastal Plain birds in the winter may be due to the preference for wax myrtle berries, these being absent from the Piedmont.

The stomach contents of birds in the spring from both the Piedmont and Coastal Plain were composed entirely of animal matter. In addition to the above-mentioned orders of insects commonly found in the stomachs of wintering Piedmont birds, spring birds from the Piedmont also ate considerable numbers of Homoptera (chiefly aphids) and a few Neuroptera.

MOLT AND GONADS

Molt.—Table 5 indicates the extent and intensity of the prenuptial molt. Of the areas of the body involved, molt on the breast and back seemed to be completed faster than molt on the head, neck, rump, and flanks. Molt occurred commonly among the secondary wing coverts and occasionally in the primary coverts.

Gonads.—All seven males taken on the Piedmont during May showed testicular recrudescence. The maximum testis size was 4 mm, with an average

TABLE 6

BODY WEIGHTS AND RESULTS OF LIPID EXTRACTIONS (OCTOBER–APRIL)

	No.	Oct.	No.	Nov.	No.	Dec.	No.	Jan.	No.	Feb.	No.	Mar.	No.	Apr.
Mean orig. wet wt														
Coastal males	2	14.4	4	12.4	4	13.2	6	14.3	3	12.0	2	12.2	3	12.5
Piedmont males	3	12.7	2	12.0	1	12.8	2	12.0	2	14.1	3	12.6	3	12.8
Coastal females	1	11.2		—	4	13.1		—	1	12.0		—	3	11.8
Piedmont females	1	13.1	2	11.7	3	11.7	2	12.0	2	14.6	1	12.0	3	11.4
Florida males	1	11.5	2	12.4		—	7	12.2	2	12.3	26	11.9	2	11.8
Florida females	1	10.9	1	13.3		—	3	12.7	1	11.9	31	11.2	2	10.9
Mean % H_2O														
Coastal (N.C.)	3	61.5	4	63.7	8	61.2	6	57.9	4	61.4	2	62.3	6	66.1
Piedmont	4	61.9	4	61.9	4	62.9	4	65.0	4	57.1	4	62.8	6	63.9
Florida	2	61.2	3	59.2		—	10	58.0	3	58.6	57	59.6	4	60.6
Mean % fat-free dry wt														
Coastal (N.C.)	3	28.3	4	30.7	8	28.4	6	27.0	4	32.4	2	28.3	6	28.1
Piedmont	4	26.3	4	27.3	4	27.3	4	28.0	4	30.3	4	27.7	6	27.1
Florida	2	28.6	3	26.6		—	10	24.9	3	26.0	57	28.3	4	29.4
Mean % lipid														
Coastal (N.C.)	3	10.2	4	5.6	8	10.1	6	15.1	4	6.3	2	9.5	6	5.8
Piedmont	4	11.7	4	9.3	4	9.3	4	7.7	4	12.6	4	9.4	6	8.9
Florida	2	10.3	3	14.2		—	10	17.0	3	15.4	57	12.3	4	10.0

of 3.1 mm, compared to a size in wintering birds of 1 mm or less. Even though no males taken prior to 1 May had enlarged testes and no follicular enlargement was found in females at any time, it is quite possible that sex hormones were becoming active. There is evidence to indicate that some birds have active gonads before leaving their wintering grounds, even though there is no noticeable increase in gonad size (Marshall, 1961:328–329).

LIPIDS

Results of the lipid extractions appear in Tables 6 and 7. The three body fractions (water, nonfat dry weight, lipids) are given in per cent of the wet weight of the body minus the stomach contents (see Table 4). The weight of water was rather constant per gram of body weight, as was the amount of nonfat dry material. This observation agrees with the findings of McGreal and Farner (1956), who noted that variation in size of the lateral thoracic fat bodies in the White-crowned Sparrow (*Zonotrichia leucophrys gambelii*) was due to an increase in lipid content, the water and nonfat dry weights remaining nearly constant. The mean water content (per cent) of the Myrtle Warbler was very close to that given by Turček (1960) for the Old World Warblers (Family Sylviidae). The mean (Oct.–May) water content for

TABLE 7

BODY WEIGHTS AND RESULTS OF LIPID EXTRACTIONS (PIEDMONT BIRDS IN MAY)

	No.	1 May	No.	8 May	No.	14 May	No.	16 May	No.	May Avg
Mean original wet weight	5	12.4	8	12.6	4	14.1	3	13.4	20	13.0
% water	5	63.5	8	61.7	4	55.6	3	55.2	20	59.8
% fat-free dry weight	5	27.0	8	26.1	4	24.8	3	24.4	20	25.8
% lipid	5	9.7	8	12.3	4	19.6	3	20.4	20	14.3

Myrtle Warblers was 61.3 per cent, and the per cent of fat-free dry matter (at least protein and carbohydrate) was 28.1. These percentages varied only slightly from bird to bird, the variations in wet weight being due to the fluctuations in lipid levels. The average lipid per cent was 10.5 for all 162 specimens, but individuals were extremely variable seasonally, the means ranging (Table 6) from 5.6 per cent in November birds (coastal North Carolina) to a mean of 20.4 per cent (Piedmont birds in late May) (Table 7).

It is unlikely that the changeover to a completely insectivorous diet facilitated lipid deposition prior to migration. Odum and Major (1956) have shown that White-throated Sparrows deposit considerable amounts of premigratory fat whether they are fed on a low fat or a high fat diet. This is probably also true of the Myrtle Warbler, in that the higher animals are generally capable of breaking down a variety of organic compounds in foodstuffs and depositing these as specific lipid molecules in their bodies (Hawk, Oser, and Summerson, 1954). The fact that extensive lipid deposits are not restricted to birds on diets principally of insects is seen in Figure 1 and Table 6, because birds with midwinter lipid peaks were largely herbivorous.

Seasonal lipid deposition in Piedmont birds was bimodal with the higher peak occurring from middle to late May. A somewhat lower peak was noted in February. This midwinter peak in Piedmont birds occurs about one month later than the winter peak in Coastal Plain birds of North Carolina and Florida. A similar midwinter peak of lipid deposition was observed in the White-throated Sparrow by Odum (1949). He postulated that the midwinter peak in the White-throated Sparrow is "well-correlated with temperature since the coldest period coincided with peak weights." A similar correlation between temperature and lipid peak is apparently not true of the Myrtle Warbler, since the birds in the colder Piedmont had considerably lower lipid peaks in midwinter than those in the warmer Coastal Plain of North Carolina and Florida. Also, this explanation would not suffice for the Piedmont and Coastal Plain birds whose midwinter lipid peaks were not coincidental (Fig.

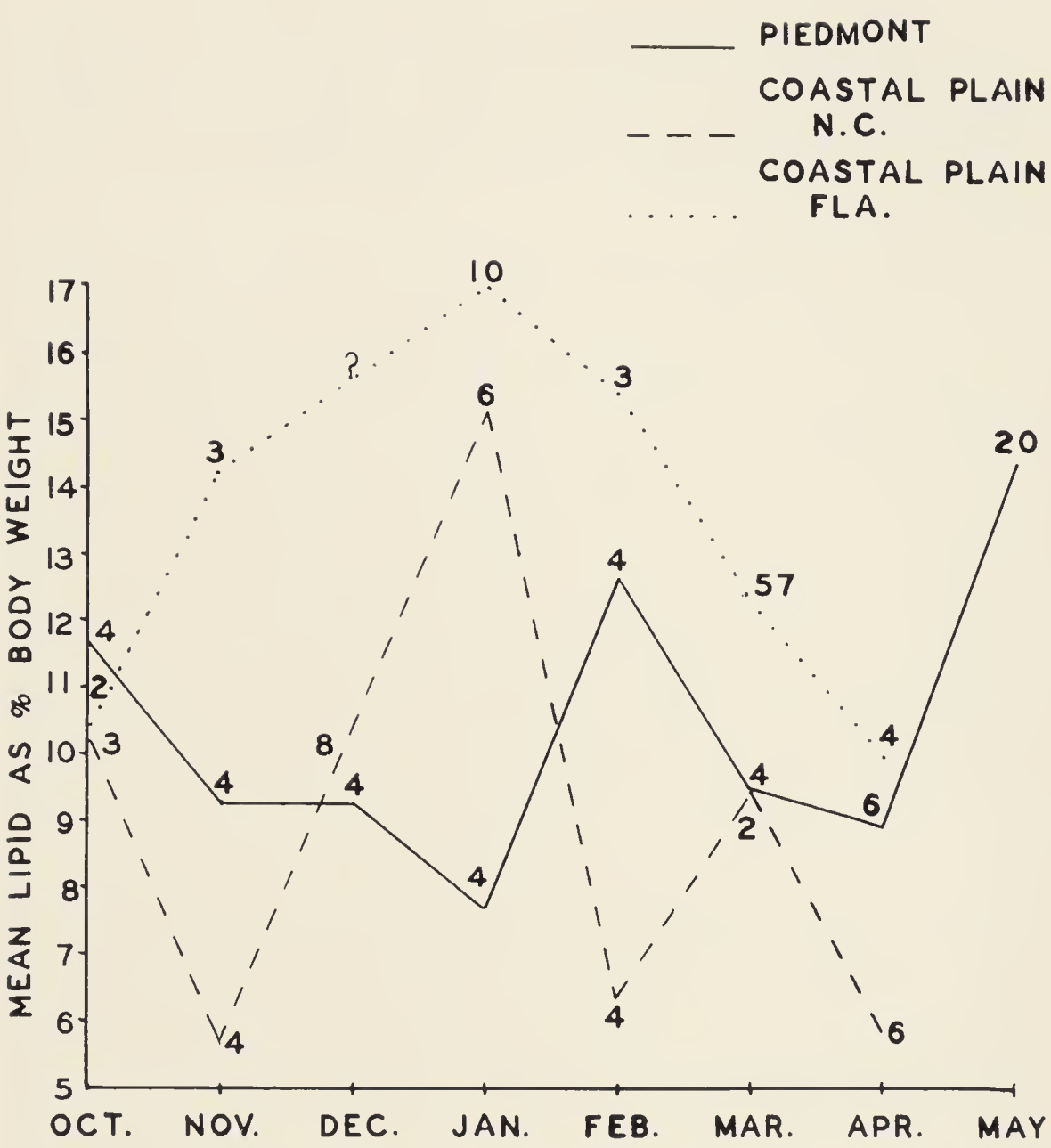

Fig. 1. Lipid levels of Myrtle Warblers from October through May.

1). Possibly the midwinter lipid peak in the Myrtle Warbler is a vestige of an adaptation that was once of survival value, but present environmental conditions may be somewhat different, and adaptive significance is not now so evident.

Coastal Plain birds from North Carolina and from Florida follow basically the same pattern with regard to lipid level, in that both groups show only one prominent peak (in January). Both groups also show a decline in lipid content until their disappearance from the Coastal Plain. At this time in late April, the lipid levels in both groups of Coastal Plain birds were the lowest at any time while the birds were on the wintering grounds. Since these birds

depart from the Coastal Plain with a low lipid reserve, it would seem that they could not migrate very far without stopping to replenish this reserve. Thus, they probably move in short hops at first, either moving northward along the Coastal Plain or northwestward into the Piedmont Plateau or both. This hypothesis is compatible with that of Chamberlain (1961) mentioned previously.

In Piedmont North Carolina birds (Fig. 1), there is also a midwinter lipid peak, which occurs in February and is followed by a decline in lipid level until late April. The periods of decline in lipid level partially correspond to the onset of the prenuptial molt, but Piedmont birds in early May were undergoing both prenuptial molt and moderate lipid deposition (cf. Tables 5 and 7). This picture is roughly similar to the one in the White-throated Sparrow (Odum and Perkinson, 1951:224), wherein premigratory "males became uniformly lean while molting, then uniformly fat." In the Myrtle Warbler, apparently most lipid deposition occurs after migration has begun. Odum and Perkinson (1951) also found a sex difference in White-throated Sparrows —the males, which migrate first, show earlier lipid deposition.

Odum, Connell, and Stoddard (1961) classified migratory birds into three basic types, depending upon lipid deposition and migratory patterns. The Myrtle Warbler, by their classification, would be considered a short-range migrant which becomes moderately fat, but begins migration before peak deposition has occurred. This is especially noticeable in Coastal Plain birds, as they begin migration at one of the lowest lipid levels of the season in late April. The same is probably true of the Piedmont birds as well, because the photoperiodic stimulus is practically the same in both Coastal and Piedmont areas. The Piedmont Plateau seems to be the main avenue of vernal migration in this species; thus there would be a continuous replacement of the numbers in the Piedmont until the last birds had passed this latitude on their way north in late May. The later birds arriving at this latitude in the Piedmont would probably be migrating at a faster rate (more miles per day), a feature reflected in the increasing lipid reserves during May (Fig. 2). In various other migratory species Cooke (1915) and Lincoln (1950) suggested that as the season progresses birds fly in longer hops.

The data presented here for vernal premigratory Myrtle Warblers clearly support the hypothesis of Caldwell, Odum, and Marshall (1963) on migrating birds elsewhere in the United States. Their contention was (pp. 433–434): ". . . long-range northern migrants begin southward migration with low to moderate fat reserves and with consequent short flights, then increase their reserves with each stop until the maximum level is reached at or near points . . . where long nonstop flights are undertaken." Our data do not necessarily show a maximum fat level for the Myrtle Warbler nor is there concrete evi-

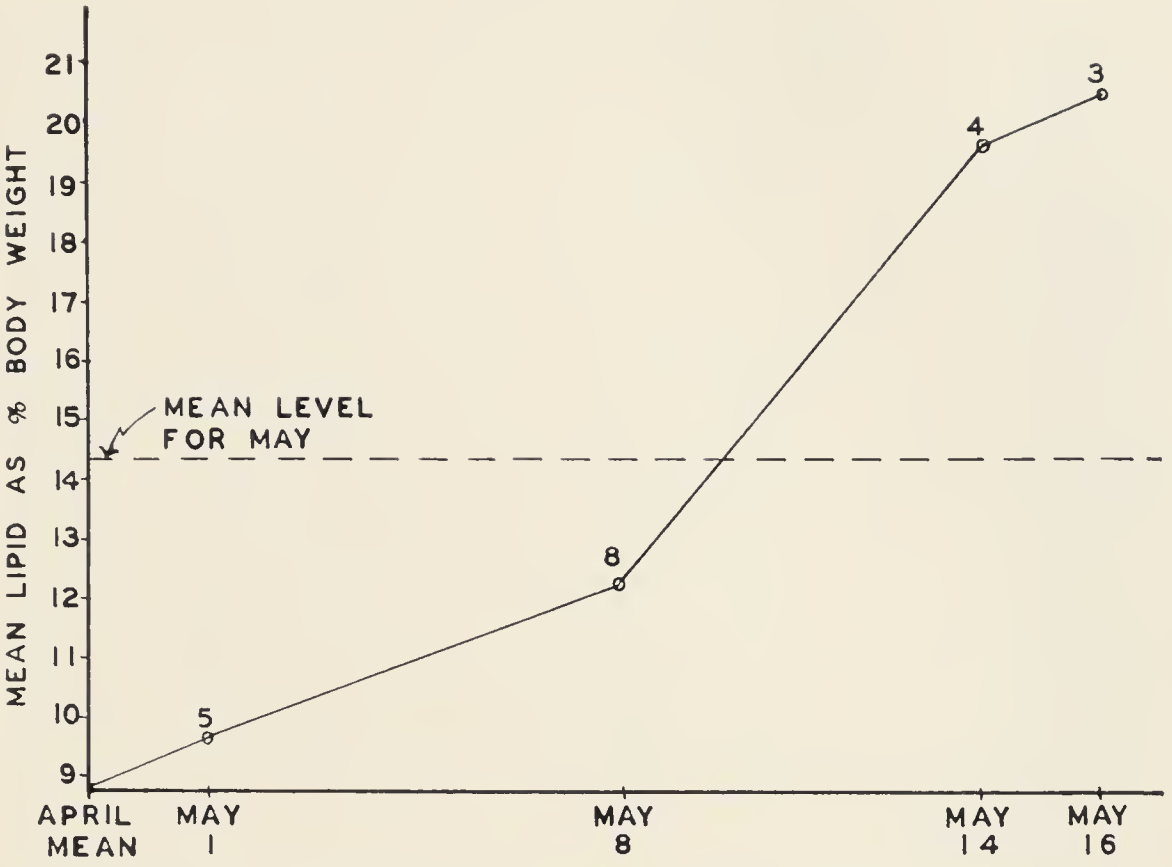

Fig. 2. Lipid levels of Myrtle Warblers taken in May on the Piedmont.

dence that this overland migrant undertakes long nonstop flights, but certainly this species does begin migration with a low body lipid level.

Some possible flight ranges based on lipid content were calculated for premigratory birds from both the Coastal Plain and the Piedmont Plateau. These estimates are based on certain assumptions (flight speed and flight energy requirements) employed by Odum, Connell, and Stoddard (1961). Values have been computed for individuals representing the extremes in fatness of each group (birds in a migratory condition from the Coastal Plain and Piedmont Plateau). The maximum flight range for the leanest Coastal Plain premigratory birds was only 77 miles and for the most obese ones, 209 miles. Of the Piedmont premigratory birds the leanest could fly 168 miles and the most obese ones, 500 miles. These maximum flight ranges are probably too high for at least two reasons. First, the gross lipid extract from the warblers was found by further refinements to contain small quantities of nonlipid impurities, presumably nonlipid portions of conjugated proteins and/or some sugars. To what extent nonlipids can be and are metabolized for flight energy has not been determined. Second, we have not considered any lipid quantity that might be necessary to sustain existence (as opposed to that providing

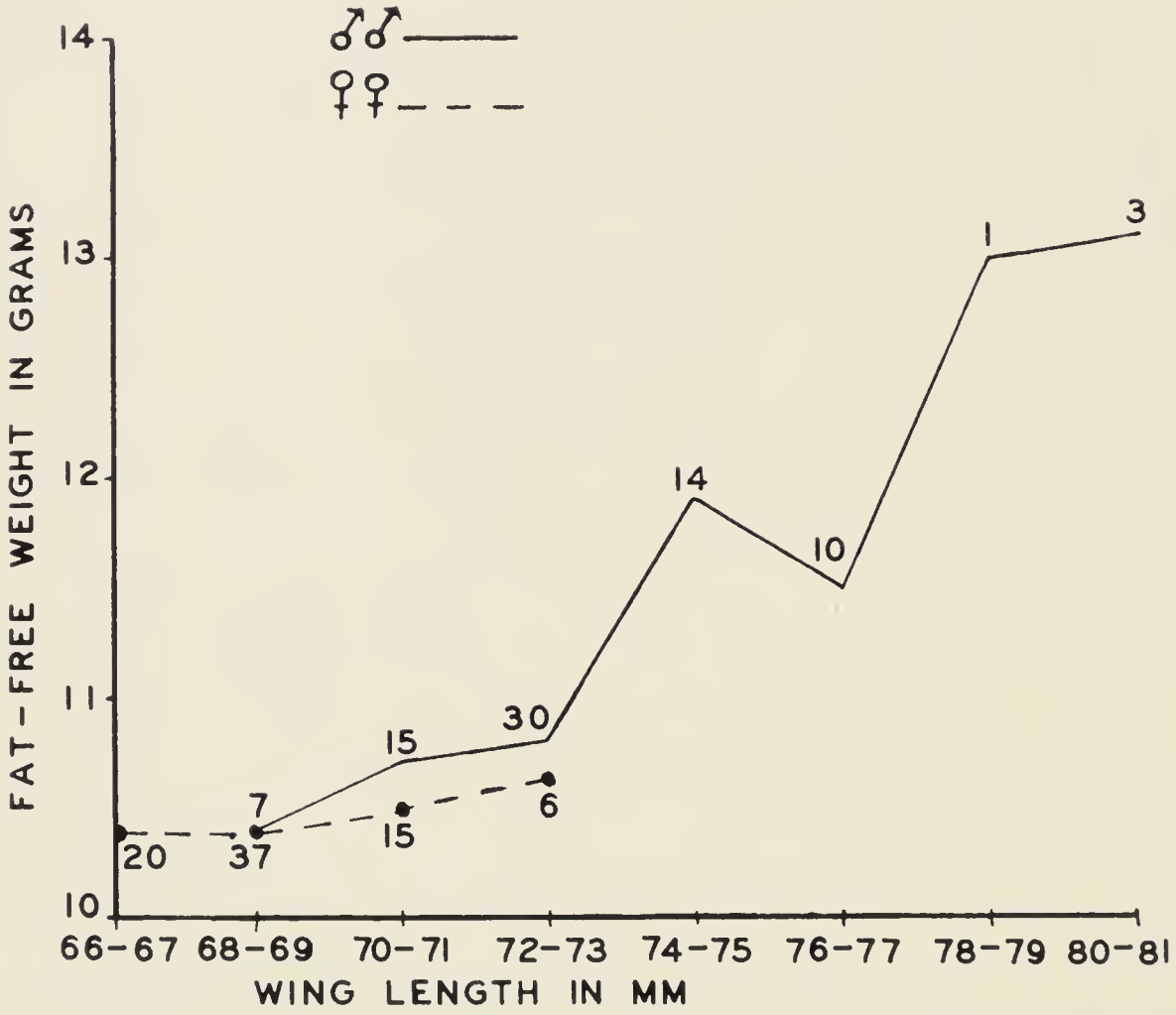

FIG. 3. Correlation between wing length and fat-free weight of Myrtle Warblers.

flight energy). For a bird the size of a Myrtle Warbler this quantity of lipid should be about 0.5 g according to Odum (1960*a*).

According to Connell, Odum, and Kale (1960), fat-free weight (total weight minus lipids) of a given species is reflected in its wing length. Thus, in the Savannah Sparrow (*Passerculus sandwichensis*), they have shown that wing length increases proportionally as the fat-free weight. In general, this is also true of the Myrtle Warbler (Fig. 3).

QUALITATIVE ASPECTS OF LIPID DEPOSITS

Three Myrtle Warblers were selected for qualitative lipid analyses. An exploratory investigation was made of the composition of the gross lipid extracts of these birds. The principal purpose of this aspect of the study was to ascertain the quantitative relationships among the three basic lipid fractions (glycerides, sterols, and phospholipids) of birds in wintering and premigratory conditions and with varying amounts of lipid deposits. The first was a wintering bird from the Coastal Plain that had a relatively high lipid level,

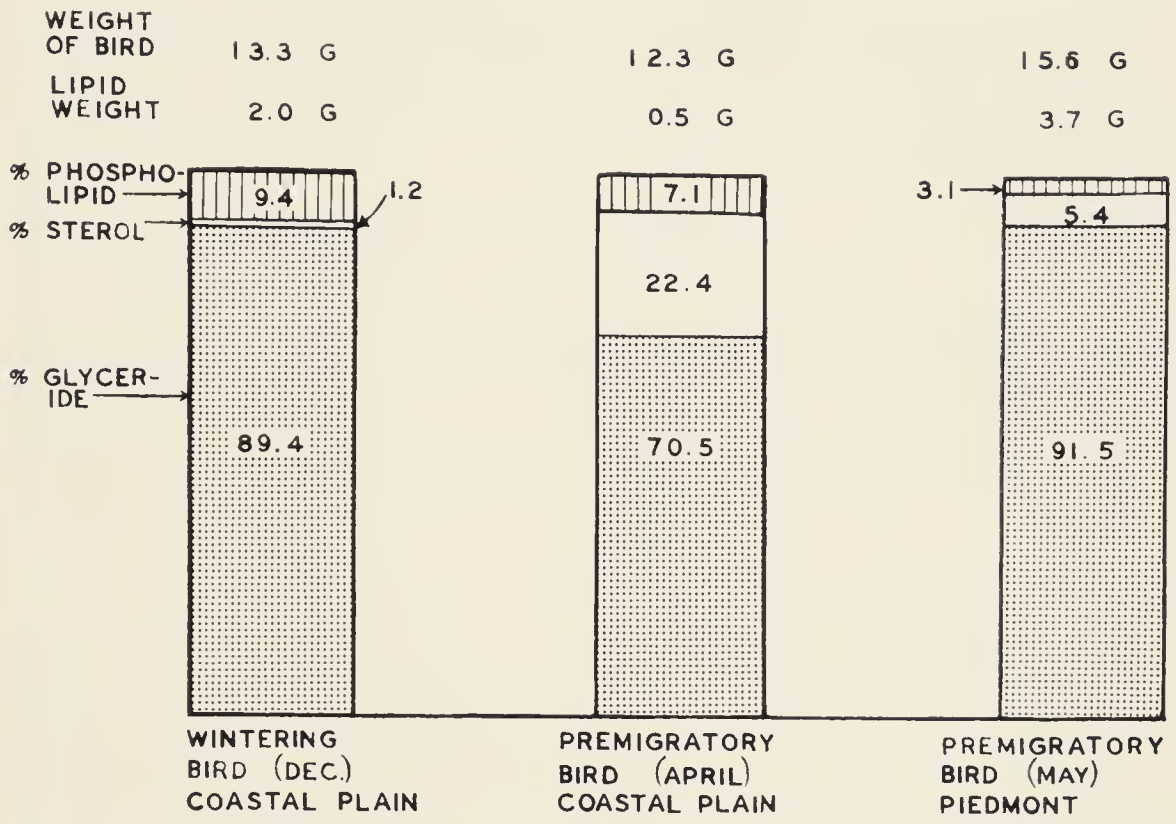

FIG. 4. Qualitative aspects of lipids from three Myrtle Warblers.

as it was building up to the midwinter peak in late December when collected.

Another Coastal Plain bird in the premigratory condition (late April) was utilized. The third bird was an obese premigratory specimen from the Piedmont (mid-May). The relative amounts of the three lipid fractions from each of the three birds are shown in Figure 4.

As might be expected, there were insignificant amounts of free fatty acids found in the lipids from the entire bird. Preliminary studies, though inconclusive, indicate that the per cent of phospholipid decreases as the time for migration approaches, and that the per cent of sterols increases. The actual amounts of sterols present in the entire bird show almost a fivefold increase in April and an eightfold increase in May over the December level. Ratios of sterol/glyceride, phospholipid/glyceride, and sterol/phospholipid varied considerably from bird to bird. Musacchia (1953) has given similar ratios (for liver and kidney lipids in some arctic migratory birds) which are comparable to December–May averages in this study.

Although there is considerable fluctuation in the ratio of sterols/phospholipids, the sum of these two fractions varies inversely as the total weight of lipid per bird. Another way of expressing this relationship which is more meaningful is that the per cent of glycerides in each sample varies directly as the amount of total lipid. Based upon these few birds in the midwinter and

premigratory conditions, these data indicate that lipid deposition is due to increases in glycerides. It is also of interest to note that peaks in lipid deposition and glyceride percentages were independent of diet (vegetable vs. animal matter; cf. Table 4 and Fig. 1).

ACKNOWLEDGMENTS

A grant from the North Carolina Academy of Sciences provided travel funds for the senior author. Herbert L. Stoddard, Sr. and Eugene P. Odum kindly supplied frozen birds from Florida, and Alden H. Miller loaned us specimens from the Museum of Vertebrate Zoology for subspecific comparisons. We wish to acknowledge with gratitude the many services provided by the Department of Biology and Graduate Council of Wake Forest College, as well as the Department of Biological Sciences at the University of Florida.

SUMMARY

From 1961–63, 84 wintering and premigratory Myrtle Warblers were taken from localities in the Coastal Plain and Piedmont Plateau of North Carolina. In addition, 81 birds were obtained from northern Florida (1960–61). These birds were weighed, measured, and sexed; ages were determined where possible; stomach contents were removed; and the birds were checked for molt. After dehydration, the lipids were extracted from each bird. The lipids of three selected specimens were assayed for the amounts of glycerides, sterols, and phospholipids present.

Subspecific identifications of the Myrtle Warblers used in this study were not attempted, and some of the difficulties involved in trying to separate *D. c. coronata* from *D. c. hooveri* are discussed.

Plant and animal matter in the stomachs were identified. Premigratory birds from both the Coastal Plain and the Piedmont Plateau changed their diets from chiefly plant material in winter to 100 per cent animal matter in spring.

Lipid deposition is not necessarily correlated with the change to an insectivorous diet, but probably to altered intermediary metabolism of the birds prior to or during migration. Support for this statement comes from the fact that the midwinter lipid peak occurs when the diet is largely herbivorous. The sharp increases in lipid level, whether midwinter or migratory, appear to be due to increases in the amounts of glycerides present.

Data on lipid levels were correlated with the relative abundance of the species in the Coastal Plain and Piedmont Plateau at different periods during the spring to explain the migratory movements of various segments of the species population. Myrtle Warblers evidently begin migrating from both localities in April with a low lipid level, these early migrants moving only a few miles a day at first. By late April, the birds had disappeared from the Coastal Plain of North Carolina. The same could be true of the Piedmont also, except that east of the Appalachians the Piedmont appears to be the main avenue of spring migration for this species and birds moving north from the Piedmont are replaced by those from farther south. The birds passing through the Piedmont later in the spring are probably migrating at a faster rate, and the longer flights can be correlated with increasing lipid levels during May. By the middle of May, Myrtle Warblers are noticeably more obese, some individuals having as much as 20 per cent of the body weight in lipid.

The prenuptial molt was almost completed by the time the birds migrated from Piedmont North Carolina. After 1 May all males taken while moving northward through this area had somewhat enlarged testes.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN; DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF FLORIDA, GAINESVILLE, FLORIDA. 26 JULY 1964

GENERAL NOTES

An unusual colony of Little Blue Herons.—There is an unusual colony of Little Blue Herons (*Florida caerulea*) on the farm of Mr. John Horner, in Mississippi County, Missouri, about 7 miles east of Sikeston, that should be of interest to ornithologists traveling in the midwest in early summer.

The colony is in a rectangular pine grove measuring less than 200 by 300 yards situated in the middle of Mr. Horner's farm and almost precisely in the northwest angle of the junction of U.S. 62 and County Road O. The soil is sandy and dry; the fields surrounding the grove are sometimes planted to crops and sometimes used to graze cattle. The Mississippi River, about 8 miles away, and the many drainage and irrigation ditches in the area apparently provide ample food for the herons, who seem contented to roost in this fairly populous neighborhood.

For the past 3 years the population of the heronry has been fairly stable, containing more than 1,000 breeding pairs and perhaps almost half again as many nonmated subadults. About 80% of the birds are Little Blue Herons and the rest are Common Egrets (*Casmerodius albus*) and Black-crowned Night Herons (*Nycticorax nycticorax*). In the summer of 1963 about a dozen pairs each of Snowy Egrets (*Leucophoyx thula*) and Cattle Egrets (*Bulbulcus ibis*) nested in the pine grove. The former had been seen in 1961 but no nest was located.

The heronry has been in existence for about 10 years, but until 6 or 7 years ago it was fairly small. There was then a rapid increase for several years until it reached its present, seemingly stable, size.

On my first visit to the heronry, 9 June 1961, I calculated the number of birds by estimating the number of active nests. This was the easier because the grove consists of pines, about 20 feet high, planted in regular rows. There were no nests in the two outer rows all around and only a few in the third row; thereafter the nests became numerous until, in the center of the grove, there were three and four nests in every tree and five in some. I eventually arrived at an estimation of 1,000 to 1,200 active nests of all kinds, and a total of 4,000 to 4,500 birds of all kinds; breeding adults, subadults, and nestlings.

On 6 and 7 July 1961, Lee Jenkins and William H. Elder, of the University of Missouri, visited the heronry. Dr. Elder subsequently reported his observations (1961, *Bluebird*, 28:13). The population they obtained by counting the evening flights into the grove corresponded closely with that which I had determined by estimating the number of active nests. Both estimates are decidedly conservative.

The herons begin to arrive at the pine grove about the first of April and continue to build up for about 3 weeks. The eggs hatch about the third week of May, and the heronry remains at a peak of activity until about the middle of July. By the end of July things are relatively quiet in the pine grove, although quite a few herons are still present and some remain in the area until the end of the summer. They do not seem to be especially troubled by the mere presence of humans, and predation is apparently slight. The loss of nestlings that fall from nests or fledglings that wander away from the nest area and starve does not seem excessive.

Although the herons seem to thrive in their unusual location and their number has apparently stabilized for the time being, the future of this colony does not seem especially bright. The birds are a nuisance to Mr. Horner, even if he does regard them with a certain pleasure and pride. He has in the past contemplated some legal method of breaking up the heronry. The birds are injuring the trees in the grove, and they are a temptation to trespassers who may damage fences. It is unfortunate that some organization such as

the National Audubon Society can not be persuaded to give Mr. Horner some kind of aid or at least moral support.—Clell T. Peterson, *Murray State College, Murray, Kentucky, 21 February 1964.*

Stylized behavior in the Turkey Vulture's courtship dance.—Mating among Turkey Vultures (*Cathartes aura*) is often preceded by a gregarious "dance." V. Coles (1938. unpublished Ph.D. dissertation, Cornell University) has described such a dance: a number of vultures gather on a cleared area where they go through a series of hops with wings outstretched; one bird hops toward its neighbor, which in turn hops until it approaches a third, etc. E. L. Tyson (MS.) has described this act as one bird lowering its head and chasing another, which in turn goes through the same actions to chase a third, etc.; meanwhile, other vultures perched in nearby trees drop down to join the dance, while some dancers break away.

In early March 1961, the authors came upon such a gregarious dance of the Turkey Vulture on a sandbar in a small Florida Panhandle river. The birds flew away immediately as we approached them. However, we examined the "dancing ground" and discovered evidence that these dances may be much more elaborately stylized than had been suspected.

Examination of the vultures' well-marked tracks on the sand disclosed two discrete, contiguous circles which formed a figure eight. One of the circles was about 6 feet in diameter, the other about 8 feet in diameter. They were well defined, with marks of trailing wings at the periphery. Each trail was approximately 15 inches wide. There were no tracks visible within the circles and very few at the outer margins. The general impression was that vultures participating in the dance obviously performed within the 15-inch width of these contiguous circles, neither breaking into the center nor standing close to the sidelines.—Horace Loftin, *Florida State University Canal Zone Program, Ft. Clayton, C.Z.*; and E. L. Tyson, *Dept. Biological Sciences, Florida State University, Tallahassee, 4 June 1964.*

American Oystercatcher and Black Skimmer nesting on salt marsh.—On 30 June 1963, my wife and I discovered a pair of American Oystercatchers (*Haematopus palliatus*) nesting on a salt-marsh island that was devoid of the sand substrate usually associated with this species. The island, called locally Ham Island, is located in Little Egg Harbor Bay, Ocean County, New Jersey. The nest was found in the upper driftline of dead grasses and eelgrass about 15 feet from the western edge of the island. The drift was situated atop Spartina grasses, which in turn, were growing in salt-marsh peat. There was no sand or similar material anywhere in the area. The nest itself consisted of a very slight depression in the drift grasses and contained two eggs. Common Terns were nesting in similar situations about 35 feet away.

We returned to the island on 14 July. The birds were stationed about 100 feet north of the nest location and were very agitated at our presence. The nest was empty. Despite considerable searching, we were unable to locate any young birds.

During June and July, we visited most of the islands between Barnegat and Beach Haven Inlets. At a number of these we discovered Black Skimmers (*Rynchops nigra*) also nesting in the driftline over salt-marsh grasses without association with sand. The nests were slight depressions in the drift material. This type of nest site was even used on islands which contained some areas of sand beach in addition to the salt marsh. It was also used on islands composed entirely of salt marsh. The skimmers were successful in hatching and raising young in these locations.

I have not been able to find reports of this type of nest location for either of these species.

Beyond being an apparently new nesting substrate for these species, I believe there may be significance in their choosing this type of nest location. The sand areas in the coastal regions near the metropolitan centers are receiving increasingly heavy human use. On the islands in use by the skimmers which contained both sand and salt marsh, the sand areas received constant intrusion by boating parties. If these birds can successfully use the less visited salt-marsh islands to nest, it could have significant survival value. For the oystercatcher, it might aid its continued recapturing of range.—Robert C. Froiling, *Belle Mead, New Jersey, 29 April 1964.*

Additional records of Brown Thrashers parasitized by the Brown-headed Cowbird.—Friedmann (*in* Bent 1948. *U.S. Natl. Mus. Bull.* 195:370) states that the Brown Thrasher (*Toxostoma rufum*) is the largest passerine bird parasitized by the Brown-headed Cowbird (*Molothrus ater*), and "a decidedly uncommon victim" of the parasite. The observation in 1868 by J. A. Allen on a Brown Thrasher feeding a cowbird in western Iowa remained unique until recent years. In 1943, Moore (1956. *Auk*, 73:558) saw a thrasher feeding three young fledged cowbirds. Nickell (1955. *Auk*, 72:88–92) found three pairs of Brown Thrasher nests which had young cowbirds. One nest contained three thrasher eggs and one cowbird, and another nest held two thrashers and two cowbirds. The third nest contained four young Brown Thrashers and one young cowbird. More recently, Friedmann (1963. *U.S. Natl. Mus. Bull.* 233) gives 31 records of cowbird parasitism on the Brown Thrasher; reports that range from certain parts of Canada, to Connecticut, Pennsylvania, Maryland, Illinois, Michigan, and Iowa to Minnesota, Wisconsin, Kansas, North Dakota, Nebraska, Missouri, Tennessee, and Oklahoma.

While conducting research on the avian fauna around Ruston, Louisiana, three incidents of Brown Thrasher parasitism by the Brown-headed Cowbird have been recorded. To our knowledge, these are the first records of cowbirds parasitizing the Brown Thrasher in the state of Louisiana. The first nest, containing two Brown Thrasher eggs and one egg of the cowbird was located on 18 April 1964. The following day three eggs of the host and the one egg of the parasite were in the nest. The third observation of the nest was on 23 April 1964. There were four eggs (the completed clutch) of the thrasher and no cowbird egg. In this particular observation, apparently after the clutch of the thrashers had been completed, or shortly thereafter, the adult thrasher may have disposed of the cowbird's egg.

The second nest was in the vicinity of the first. When this nest was found (18 April 1964), it contained one thrasher egg. On 26 April 1964, an examination of the nest revealed three Brown Thrasher eggs and two eggs of the Brown-headed Cowbird. Three days later, three eggs of the host and the two eggs of the parasite were in the nest. By 2 May 1964, the two cowbird eggs had hatched, along with the two eggs of the Brown Thrashers. The third thrasher egg was pipped. The young cowbirds were not more than 1 day old. Further observations of the nest were made on 3 May 1964. The nest contained the two young cowbirds and three young of the Brown Thrashers. The next day, the young cowbirds were gone, but the young thrashers remained in the nest. In that the nest was not destroyed and contained the young thrashers, it is suspected that the adult thrashers removed the two cowbirds. How the nestling cowbirds were removed is unknown.

The third record of parasitism was found when a vacated nest of the Brown Thrasher was located containing one cowbird egg, which had been covered over with grasses and other vegetation to the extent that a new nest had been built over the old one. We have

not read or heard of the Brown Thrasher placing material over a cowbird egg as recorded for some of the warblers.

From these observations, the Brown Thrashers coped with the parasitic cowbird in three ways: by covering over the egg, by disposing of the egg, and by eliminating the young.—Walter K. Taylor and John W. Goertz, *Department of Zoology, Louisiana Polytechnic Institute, Ruston, Louisiana, 25 May 1964.*

Common Grackle attacks Dickcissel.—On 22 April 1964, in Weston, Middlesex County, Massachusetts, Mr. Elliott W. Hall witnessed a Common Grackle (*Quiscalus quiscula*) attacking a Dickcissel (*Spiza americana*) in his yard.

When first seen, the Dickcissel was feeding with House Sparrows (*Passer domesticus*) on the ground. The sparrows scattered when four grackles flew in, but the Dickcissel remained and was immediately attacked by one of the grackles. The action was swift but Mr. Hall believes that the grackle struck at the Dickcissel with its bill and at the same time grabbed it with its feet. Although pecked on the head several times, the Dickcissel escaped and half-hopped–half-fluttered to a nearby small cedar, all the while being harried by the grackle. The grackle was finally chased away by Mr. Hall's daughter and the Dickcissel was lost to sight.

Later that afternoon the Dickcissel was found dead in the yard and taken to the Drumlin Farm Wildlife Sanctuary of the Massachusetts Audubon Society in Lincoln, where the bird was examined and prepared as a study skin. There were no lacerations on the body of the bird but the skin was contused and feathers were missing from the area just above and behind the left eye. There was a small hole in the interorbital region of the skull. The bird was thin, with the pectoral muscles moderately eroded. It had just completed its prenuptial molt and was a male with enlarged testes. It weighed 21.8 gms and had a wing length (chord) of 80 mm. The skull was completely ossified.

The carcass was examined by Dr. George P. Faddoul at the Avian Diagnostic Laboratory of the University of Massachusetts' Waltham Field Station and was found to be free of internal parasites and bacteriological tests were negative for bacterial pathogens.

Although the grackle's fondness for eggs and nestlings is well known, it is less clear to what extent they prey upon free-flying birds. There are several published accounts of grackles attacking and killing fully fledged and adult House Sparrows (Forbush, 1927. Birds of Massachusetts and other New England States. Vol. II:459; Taylor, 1958. *Auk*, 75:222–223; inter alia), and we have been told of several instances of attacks on House Sparrows. But in only one of these reports are there details of the actions of the birds *prior* to the attack.

In view of the improbability of a grackle successfully pursuing and capturing a healthy small bird, it seems to us most likely that grackle attacks are largely limited to newly fledged young, or to birds that are sick, disabled, or *appear to be disabled.* It is this latter point that would seem to account for the apparently frequent attacks on House Sparrows, since (1) House Sparrows and grackles are common associes. (2) the sparrows are frequent bathers (dust and water), and (3) the fluttering action of the wings while bathing would make it appear that the bird was disabled and thus "release" an attack by the grackle.

In the case of the Dickcissel, the attack may have been motivated by the fact that the Dickcissel did not fly when the sparrows did, and therefore appeared "sick." And in view of its somewhat emaciated condition, it may have actually been sick.—James Baird, *Massachusetts Audubon Society, Lincoln, Massachusetts,* and Charlotte E. Smith, *75 Westland Road, Weston, Massachusetts, 20 May 1964.*

A male Cardinal helper at a nest of Yellow-breasted Chats.—Although the review by Skutch (1961. *Condor*, 63:198–226) indicates that the feeding of nestling birds by adults of other species is not as uncommon as might be expected, it seems worthwhile to note the tending of three young Yellow-breasted Chats (*Icteria virens*) by a male Cardinal (*Richmondena cardinalis*). Other instances of interspecific helping by Cardinals are listed by Skutch, but apparently there are no previous reports of the chat as the recipient of assistance from any species.

The observations were made at Bloomington, Indiana, on 15–18 June 1964. I had made regular visits, since the eggs were laid, to the chats' nest, which was 25 inches from the ground. A Cardinal nest, 51 inches from the ground and located about 25 yards away in the same thicket, had been laid in on 7, 8, and 9 June. The helper male Cardinal was unbanded, but all indications are that he was the mate of the female associated with the nest last referred to.

While banding the six-day-old nestling chats on the morning of 15 June, I noted the Cardinal as he perched nearby with food and called in apparent alarm at my presence. A search for a possible nest of Cardinal nestlings was unsuccessful. At noon on 16 June, the male Cardinal was again carrying food a few feet from the chats' nest, and it soon became clear that this nest was his objective. His constant calling as I stood 8 feet from the nest attracted a female Cardinal, which called too but disappeared after half a minute. I then retreated about 10 yards and the male Cardinal immediately went silently to the nest and fed the nestling chats. After 1 minute on the rim of the nest, he moved away about 5 feet, and sang repeatedly for 3 minutes. He then disappeared but returned within a minute, this time without food; he went no closer to the nest than 3 feet, singing regularly at that point.

The first appearance that day of a parent chat then occurred. This bird carried food but would approach the nest no closer than about 15 yards. As the chat began to utter alarm calls, the Cardinal hopped silently to a perch 1 foot above the nest; after a minute it joined the chat in a nearby tree. The two birds sat 5 feet apart, both watching me but only the chat calling. Thick brush now obstructed my view, and after several minutes in which there were no developments I left.

On 17 June, alarm notes of both Cardinal and chat were heard in the thicket around the nest, but no other observations were made. By 18 June, the young chats had left the nest. The alarmed behavior of the parent chats at my visits to the vicinity on and after 18 June never attracted the Cardinal, which no longer showed any interest in the locality. But it might be noted that the nearby Cardinal nest succumbed to a predator, also on 18 June, and this may have initiated events which engrossed the male Cardinal's subsequent attention.—Val Nolan, Jr., *Indiana University, Bloomington, Indiana, 22 June 1964.*

Wing and opposite leg stretch by Bengalese Finch.—Approximately five times during a period of 1 month, April, 1964, I observed a Bengalese Finch (*Lonchura striata*) stretch with the wing and the opposite leg. In this, the wing was spread and extended sideways and upward; the opposite leg was stretched downward and slightly to the outside. The finch also stretched with the wing and corresponding leg. To my knowledge this is the first time a wing and opposite leg stretch has been observed in any species.—Becky Myton, *Department of Zoology, University of Maryland, College Park, Maryland, 28 June 1964.*

ORNITHOLOGICAL NEWS

The University of Minnesota announces the James Ford Bell Delta Waterfowl Fellowship for studies in basic biology of waterfowl. Applications should be sent to, or further information obtained from, W. J. Breckenridge, Director, Minnesota Museum of Natural History, University of Minnesota, Minneapolis, Minnesota 55455. Deadline for application for 1966 is 1 August 1965.

XIV INTERNATIONAL ORNITHOLOGICAL CONGRESS, GREAT BRITAIN, 1966

Dr. N. Tinbergen, Secretary-General of the Congress submits the following information.

The Scientific Meeting will be held at Oxford, 24–30 July 1966. The meetings will consist of Plenary Sessions in the mornings, featuring invited speakers in selected fields of ornithology, and Sectional Sessions in the afternoons at which short offered papers will be read. There will be exhibits, film shows, a Social Center, and a whole day excursion. Accommodation will be arranged in the University Colleges at approximately 50/ ($7) per day.

A Study Cruise on the 12,800 ton liner *Devonia* will be held from 16–23 July 1966. This cruise will leave Glasgow, sail around the north of Scotland to Edinburgh. This trip will visit numerous seabird islands and parties will be landed on some islands. Accommodations on board will be in dormitories costing approximately 30 £ ($84) per passenger, and in a limited number of 1-, 2-, 3-, and 4-berth cabins costing up to approximately 75 £ ($210) for a 1-berth cabin.

The Congress fee will be 10 £ ($28) for Full Members and 7 £ ($19.60) for Associate Members. The Congress is open to all ornithologists over the age of 18 years.

Application forms for the Congress and the Cruise, or the Congress alone, as well as further details can be obtained from:

The Secretary-General
International Ornithological Congress
c/o Department of Zoology
Parks Road
Oxford, England.

After over seven years Dr. Robert A. Norris has asked to be relieved of duties as a member of the Editorial Advisory Board of the *Bulletin*. This Editor, and I know I speak for the two previous Editors, wishes to express the thanks of the Society to Dr. Norris for his excellent service.

ZIP Code numbers have recently been applied to the mailing list of the Wilson Society. Your Treasurer therefore requests that members and subscribers include their new ZIP Code numbers when they change addresses. Compliance with this request will avoid delays in receiving *The Bulletin*, and will be greatly appreciated by the Treasurer.—C.C.R.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

BOOKS: List B-7

The following supplementary list includes books new to the library since December, 1962, when List B-6 (*Wilson Bulletin*, 74:428–432) appeared. Reprints of this and earlier supplements are available to members from the Josselyn Van Tyne Memorial Library, Museum of Zoology, The University of Michigan, Ann Arbor, Michigan.

Incorporation of further increments of the library of the late Josselyn Van Tyne, the gift of Mrs. Van Tyne, accounts for a very substantial number of these recent additions. In addition to those books received as gifts from other members, many have been purchased outright through the New Book Fund. This fund, despite increased use, is still being maintained at satisfactory levels by sale of duplicates and by continued member contributions.

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TRANSLATIONS

The following is a list of translations of foreign-language articles received in the library since the publication of List B-6. The Society is deeply indebted to Mr. Leon Kelso who prepared and donated all of the items listed below.

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The following gifts have been recently received. From:

James L. Baillie—1 pamphlet
Ed Brigham—5 journals, 4 reprints
Pierce Brodkorb—1 book, 7 reprints
W. H. Burt—2 books
George A. Clark, Jr.—15 reprints
C. T. Collins—2 reprints
F. G. Cooch—1 reprint
Julian L. Dusi—28 journals
Jack P. Hailman—1 reprint
Karl W. Haller—6 reprints
J. Hill Hamon—1 book
F. Haverschmidt—1 book
Leon Kelso—2 books, 2 journals, 17 translations, 1 reprint
S. Charles Kendeigh—5 reprints
Robert C. Lasiewski—2 reprints
Robert C. Leberman—21 journals
W. A. Lunk—1 book
Daniel McKinley—20 reprints
Richard H. Manville—16 reprints
Harold Mayfield—1 book, 39 reprints
Robert M. Mengel—10 reprints
Mrs. Emery Neff—3 books, 43 journals, 20 reprints
Margaret M. Nice—7 journals, 18 reprints
S. Dillon Ripley—2 journals
William B. Robertson, Jr.—2 pamphlets
Oscar M. Root—5 books, 20 journals, 20 reprints
C. Chandler Ross—4 journals, 17 reprints
Walter E. Scott—1 pamphlet
Charles G. Sibley—4 reprints
W. E. Southern—2 reprints
Paul A. Stewart—3 reprints
Emerson A. Stoner—1 book
Robert W. Storer—21 journals
H. B. Tordoff—4 journals
Mrs. Josselyn Van Tyne—54 books, 51 volumes of journals
K. H. Voous—6 reprints

ORNITHOLOGICAL LITERATURE

THE WORLD OF BIRDS. By James Fisher and Roger Tory Peterson. Doubleday, Garden City, New York, 1964. [year not shown]: 9¾ × 12¾ in., 288 pp., many col. illus. and maps, bl. and wh. photos. and drawings, col. end papers and jacket. $22.95.

This is a handsome addition to the new generation of large, ornate bird books aimed at a popular audience. The text was written by Fisher and Peterson; the bird illustrations were done by Peterson.

The first word that comes to mind in describing this work is *colorful*. Anyone who is moved by beautiful hues will turn the pages with pleasure, pausing particularly at the double-page spread of members of 23 families (pp. 10–11), the brilliant assortment of feathers (p. 19), the group of nectar-eating birds at their blossoms (p. 39), and others. Even the range maps and diagrams are eye-catching. The lavish use of color extends to the jacket, which has large, vivid portraits of the Mandarin Duck, Wood Duck, Roseate Cockatoos, and Cardinal, which do not appear in the book itself. Generally, the colors are sharp and true, with the exception of the plate of birds' eggs (p. 87) where the blue did not come through strongly enough, and the Catbird's and Veery's eggs, for example, give no hint of their actual shades.

By turning the pages, more easily than by studying the table of contents, we see that the book has four main parts. The first, consisting of six chapters abundantly illustrated in color, summarizes much of what we know about birds as animals. The second, consisting of one chapter illustrated with black-and-white photographs and drawings, describes the methods and tools of bird watching. The third, consisting of one very long chapter, treats 200 avian families, living and extinct, giving range maps, bird silhouettes, the geographic origin, and a count of genera and species for each. The fourth, consisting of one chapter, discusses the relationship of birds to man. There is an index and a bibliography, not of literature cited but of readings on the subjects contained.

Probably the first part (six chapters) will prove of greatest interest to most readers. It deals with the variety of birds, how birds live, birds of the past, birds on the tree of life, the distribution of birds, and bird society. Although fully half of these 86 pages are taken up with illustrations, the use of double columns of type and compact treatment of the subjects has permitted a great deal of information to be put into this space. Different readers will single out different parts of this excellent account for mention, but I believe the imaginative paintings of extinct birds from various geological periods and the portrayal of the whole family tree of bird families on one diagram particularly may catch the attention of more experienced readers.

To active field students and conservationists, the second and fourth parts, which are concerned with methods of study and birds' relationships to man, will be interesting but for the most part familiar. The authors, however, have shown special concern for historical origins, and nearly every reader will learn something about the beginnings of bird-song recording, bird listing, observation records, censusing, banding, birdhouse building, bird protection, bird hunting, egg harvesting, guano digging, falconry, aviculture, and so on.

The third part of the book, the list of families, differs in presentation from that of Van Tyne and Berger (1959, "Fundamentals of Ornithology," John Wiley, New York) principally in its inclusion of extinct families, range maps, counts of genera, and the geographic origin of each family; also it omits the summary of family characteristics, habits, food, breeding, and literature references given in the earlier work. In the

present book the families are listed in the European order. The fact that these two recent works do not often agree on the number of species in each family will confirm the impression of some readers that the judgments of taxonomists are as shifting sands. But the authors point out that their total count of species, 8,663, varies less than one per cent from most other recent counts and therefore the classification of birds at the species level has become fairly stable.

The equal-area maps centering on London or the North or South Pole are effective in portraying the spherical earth on a flat page.

As might be expected from authors of world-ranging interests and experience, and as promised by the title, the subject matter touches all continents, although examples are drawn most often from Britain and America. Also, as we might expect from men of such enthusiasm for *everything* about birds, the topics considered range from the erudite to the merely amusing, such as the necktie patterns of British bird clubs. One cannot escape the suspicion that the authors started out to write a very elementary book but were drawn by their own interests into some topics more deeply than they had intended—to the benefit of the more serious reader.

Technical subjects are handled according to the most recent scientific viewpoint—very advanced indeed in the discussion (pp. 90–91) of "pullus . . . adopted as the official word to represent a bird that has hatched but cannot yet fly." This term has merit but it seems not yet to have come into universal use if we may judge from its absence from the indexes of recent American textbooks and journals. In a similar category on the same page may be the use of juvenal as a noun ("As soon as a bird can fly it is a juvenal."). In American usage, "juvenal" is an adjective referring to a plumage.

Insofar as I am able to judge, the text is technically sound. Nevertheless, not surprisingly in the first edition of a work that dips into so many phases of a broad subject, it is not infallible in some minutiae. For example, in a mention of two censuses of the Kirtland's Warbler (p. 73), there were errors in one of the dates and in the amount of area occupied by the bird. Also I would quibble over the statement (p. 89) that the Brown-headed Cowbird lays "usually just after the first egg has been laid by the host." Yet none of these slips of the pen damage the point of the account. John Emlen will be surprised to be called James (p. 98), and George Lowery, to read that he is at Kansas University (p. 125); but these items will be noticed only within the family of American ornithologists. Certainly I do not mean to imply by them that the book was carelessly written or that typographical errors are numerous.

Although the book was aimed at a wider public, I think many serious students of birds will want it in their libraries. Why? Most obviously, it is a beautiful book to have in your home for visitors to thumb. Further, some of its chapters with their examples from all parts of the world, deserve to be read by all beginners and will claim the attention of more advanced students. And finally, this book contains a remarkable number of curious bits of information that would be difficult to find elsewhere, such as the following: a list of endangered species (pp. 268–271), species that have become extinct since 1600 (pp. 272–273), many historical origins (first use of bird bands, date of founding of the oldest zoos, etc.), bird densities in various types of habitats over the world (p. 112), largest and smallest eggs (p. 86), wing-spans of the largest flying animals and the weights of the largest birds (p. 24), and size of the check-lists in different regions of the world (pp. 12–13). A few readers might wish some of these facts were presented in conventional scientific form, with references, measurement of variation, and size of sample, but these could hardly be expected in a book for the general public.

In brief, this is both a picture book and elementary textbook of ornithology.—Harold Mayfield.

Song and Garden Birds of North America. By Alexander Wetmore and Other Eminent Ornithologists. National Geographic Society, Washington, D.C.: 7 × 10¼ in., 400 pp., 550 photos. (mostly col.) and paintings; bird-song album (inside back cover) of six LP vinyl recordings produced by Cornell Laboratory of Ornithology. $11.95.

This latest volume in the National Geographic Natural Science Library is a typically handsome production filled with gorgeous pictures, chatty captions, and informative text. It wins extra points for being a comfortable size to handle in a day of increasingly unmanageable bird books.

The color photographs are by such top wildlife cameramen as A. A. Allen, Allan D. Cruickshank, and Eliot Porter, supplemented by paintings by Allan Brooks, Walter A. Weber, and George Miksch Sutton. Each of the 327 North American species from the hummingbirds through the fringillids is portrayed. In addition there are many fascinating action pictures which serve to enliven the text.

After introductory chapters on "The Way of a Bird" and "Birds in Your Garden" by Wetmore, chapters follow on each of the bird families. Each chapter contains an introductory essay by a well-known ornithologist such as Aldrich, Lowery, Pettingill, and Sutton, or by staff writers, and write-ups of each species which give details and anecdotes about the bird's habits and in a final paragraph its range and characteristics. For good measure there are also included a chapter on "Courtship and Mating Behavior" by Robert M. McClung and a final one by Roger Tory Peterson entitled "What Bird Is That?".

The truly unusual aspect of this book is the inclusion in a pocket inside the back cover of an album of bird songs narrated by Peter Paul Kellogg of Cornell University. This is a most ingenious arrangement of records which permits playing them without removing them from the booklet into which they are bound merely by folding the pages back and placing the entire booklet on the turntable. Careful and clear instructions tell how to play the records on an automatic changer as well as manually. It is possible to select individual bird songs on any record and each song is cross-referenced to the page of the text where the singer is described. Songs of seventy birds are grouped either by family ("An Evening With Thrushes") or geographically ("At Sunset in a Midwest Meadow"). The records are first-class as would be expected from Cornell.

"Song and Garden Birds" should be a very popular book. It is both attractive and instructive with a "zestful text" (to quote the jacket) and handsome pictures.—Edward F. Dana.

Introductory Ornithology. By George E. Grube. Wm. C. Brown, Dubuque, Iowa, 1964: 6 × 9 in., x + 294 pp., many photos. and drawings. $4.75.

In recent years the instructor has been able to choose from a number of excellent texts in ornithology. These reflect the great strides made in ornithological research and the accumulation of data. When one considers that over 1,000 serials contained material on avian biology during the early 1960's (Baldwin and Oehlerts, 1964. "The Status of Ornithological Literature," Biological Abstracts, Inc.), the need for still more texts to digest and organize this material is obvious.

An instructor examining a new text looks for a fresh approach to the subject matter, or a different emphasis; and he expects at least to be brought up to date on current

findings in the field. This author's approach is curiously outdated; his homogenized treatment produces an inevitable superficiality; and he fails to bring the reader into the present decade of ornithological knowledge. Although professing to be an introductory text and manual for a one-semester college course, the book falls far short of meeting those goals.

Eleven chapters in this book deal with the external features of birds, their internal anatomy, origin and history, taxonomy, distribution, ecology, migration, life history, song, and economic value. Final chapters discuss the history of American ornithology, bird art, methods in ornithology, and attracting birds. Appendices include an illustrated key to the orders and families of North American birds, a series of range maps to be completed by the student, and some suggested problems in ornithology.

One of the book's shortcomings is its lack of comprehensiveness. Aside from the key and appendixes, the text is only 177 pages including bibliographies, numerous illustrations, and "exercises." It is impossible for even the most laconic writer to present a college text on ornithology in a mere 177 pages. The material is bound to be superficially treated or misleadingly simple, and the narrow spectrum of ideas will greatly limit the instructor.

Grube does not present ornithology as the dynamic science it is, but rather, I suspect, as it must have been taught many years ago. He does not mention recent advances in the field. Although evolution is the main theme of biology, he fails to discuss the evolution of birds per se, except as it appears in the fossil record. Evolutionary mechanisms are not explained. Species concepts and speciation are not mentioned. Not even the classic example of the Galapagos finches appears in the text.

The chapter on ecology does little more than characterize the major environments and list the principal birds that belong in them. The author does not examine the anatomical, physiological, and behavioral features that permit various species to live in the desert or arctic environments. Salt glands and thermoregulating mechanisms are not mentioned. Although theories of orientation and the effects of weather on migration have received a great deal of attention on both sides of the Atlantic in recent years, this text disposes of them in slightly more than one page.

Studies of bird behavior have contributed much to the thriving young science of ethology. It seems strange, then, that one cannot find any reference to the terms "displacement activity," "agonistic behavior," "imprinting," and others that appear so frequently in papers on bird behavior. In the brief section on territory, Grube does not show the actual size of territories in different groups of birds, or state the functions and requirements of territoriality in species about which these things are known.

An eight-page chapter on bird song is primarily a discussion of the methods that a student might use in recording songs and calls with words, symbols, and tape. The author fails to treat the development, significance, and variety of vocalizations, or their use as a taxonomic tool. In spite of the fact that this chapter deals with methods, he does not mention the use of the audiospectrograph as a tool of research; nor does he do so in the chapter on methods in ornithology.

Throughout the text, examples are lacking, often where they are most needed. For instance, the author states that "The sequence of plumages is quite variable in different species of birds and sometimes varies within species depending upon geographical distribution." No examples are given. Nor does he furnish the reader with any of the twelve names of families restricted to the Australian Region, or those endemic to the Holarctic Region. Migration routes are briefly discussed without giving any instances

of the species of birds that follow certain routes. The author discusses the plumage changes occurring in the life of a bird. Not one example is given.

There are few typographical errors, but three words are consistently misspelled in the index as well as in the text: *Archaeopteryx*, *Archaeornis*, and Hoatzin. The illustrations by William C. Dilger definitely enhance the text. A few (not done by Dilger) are misleading or, such as the drawing of the avian eye, inaccurate. The illustrated key attempts to combine a synopsis of orders and families with a guide to identification, thereby limiting its intended usefulness.

At the end of each chapter the author includes a list of publications that have a double purpose, a bibliography plus suggested references to students. A number of basic works are omitted including those of Heilmann and Swinton on the fossil history of birds, Darlington's "Zoogeography," and Dorst's "The Migrations of Birds," all primary references which students should read. Although the book contains a discussion of extinct and vanishing birds, Greenway's excellent treatment of the subject is omitted from the bibliography.

One might well argue that ornithology is so broad a science now that there is room for many texts with different approaches and varying degrees of comprehensiveness, and that the merits of a text should be judged on the accuracy of its contents, since a consideration of anything else is likely to elicit only the biases of the reviewer. Let us turn our attention, then, to the veracity of the material presented in the text.

Surprisingly, we learn that "This [the alula] is composed of a group of feathers which apparently function as flaps which brake flight when the bird alights." No aerodynamic function of the alula in soaring or slow flight is mentioned. On avian anatomy the author states that the synsacrum includes the pelvic girdle and the lumbar, sacral, and "urosacral" vertebrae; and that the tibia, fibula and some of the tarsals are fused together to form the "tibiofibula." On reproduction, the author writes that "it normally takes the egg from 3 to 12 hours to pass from the ovary to the cloaca in the domestic hen and as much [sic] as 18 hours in some wild birds." "The sandpipers produce pear-shaped or conical eggs. . . ." The egg tooth "cuts a groove around the large end of the egg shell."

In every chapter I found incorrect and misleading statements. In comparing the avian and mammalian lungs the author remarks that "One-third of the capacity [in the mammalian lung] holds residual air which serves to prevent the lungs from collapsing." Actually, it is the negative intrapleural pressure that prevents the lungs from collapsing. Concerning fossil forms, Grube states that "*Hesperornis* was already a degenerate form. . . ." and that "*Ichthyornis* had its teeth inserted in separate sockets. . . ." We learn further that *Archaeopteryx* and *Archaeornis* are now placed "in separate families."

It will come as a surprise to many to learn that, according to Grube, the only family of birds restricted to the Oriental Region is not the family Irenidae, but Paradoxornithidae. Students may well challenge such statements as "The variations [in pigmentation of eggs within a species] probably are caused by differences in the vigor of the reproductive system." and "Most young are forced from the nest by starvation." The statement that "Grebes, rails, gallinules, coots, etc., have laterally lobed toes." is inaccurate; it applies only to grebes and coots. "The screech owl (*Otus asio*) in the eastern United States is often erythristic while in the western United States it is always normal gray." Not so. Two races in the west have color phases, one of which is usually dark brown. The range of body temperatures in birds is listed at 110 to 115 degrees Fahrenheit. This is too high. Farner and King (*in* Marshall, "Biology and Comparative Physiology of

Birds," volume 2) have compiled a long list of body temperatures that range from 99.8 to 110.3 degrees Fahrenheit.

In the paragraphs above I have mentioned only a few of more than 80 misleading and erroneous statements that appear throughout the text. Although the book is very superficial, the author does include a number of ludicrous statements that should have been omitted: such as "Migration . . . is a manifestation of flight." and "The fore part of the skull is covered by a horny layer to provide a bill or beak, hence birds do not have fleshy lips." Even if this book made no claims as a text, one could not excuse its multitude of errors. Since Grube does indeed designate his book as a teaching guide, one can only wonder at the naïveté of an instructor who could suppose that this presentation would be adequate for today's sophisticated students.—Douglas A. Lancaster.

The Birds of Natal and Zululand. By P. A. Clancey. Oliver and Boyd. Edinburgh and London, 7⅝ × 10⅞ in., xxxiv + 511 pp., 41 col. pls., text figs., photos., map. 84s.

We are happy to welcome Mr. Clancey's volume to the growing list of African bird books. It is unique in two ways: it is the first major work on one of the political subdivisions of southern Africa, and more important, it is the first to be written for a resident population of ornithologists. Bannerman's "Birds of Tropical West Africa," Jackson and Sclater's "Birds of Kenya Colony and Uganda Protectorate" and Archer and Godman's "Birds of British Somaliland" were written at a time when bird study in the colonies was limited to a few, and these books were directed as much to the specialist and bird lover in England as to the man in the field. In Natal, however, there is a large body of indigenous ornithologists, both professional and amateur, and it is for them that Clancey writes.

For many years the basic bird book of South Africa has been Roberts' "Birds of South Africa" (1940), revised and rewritten by McLachland and Liversidge in 1957. More recently, it has been joined by Mackworth-Praed and Grant's "Birds of the Southern Third of Africa" (1962–1963). In both these volumes, descriptions of variant plumages have been of necessity kept to a minimum and geographic ranges given only in general terms. To supplement them, Clancey set himself the task of "preparing detailed colour descriptions not only of the breeding adults, but of sexual, seasonal and other differences, as well as the plumages of the sub-adult and juvenile stages" and "to provide a reasonably complete and accurate statement on the past and present status of any given species." In this he has succeeded very well.

Following his introduction, Clancey gives a brief historical summary of collecting done in Natal and Zululand (the two are one for administrative purposes, but were politically separate until the time of Union and are still thought of as such, much like the present status of the United States and Alaska). Then comes a description of the physical conditions and vegetation of the country, which are important for an understanding of the distribution of the birds and the comparative richness of the avifauna. Although Natal lies wholly outside the tropics, the coastal evergreen forests act as a corridor down which many tropical birds penetrate from Moçambique, while the higher, more arid interior supports a large part of the temperate Cape avifauna. Altogether 592 species are known from Natal (sine lat.), a respectable number for a small subtropical area.

In the heart of his volume, the systematic list, the author includes all species for which there are specimen records, plus two conspicuous species for which there are sight records. Birds of doubtful occurrence or which appear in adjacent areas and are of probable occurrence, are placed in brackets in their appropriate places, thus obviating the need for hypothetical lists. American readers particularly will be pleased to see

that the order of families is that of Wetmore (1951), which is essentially that of Roberts as well. Under each species appear the scientific and vernacular names, with the citation of the original description. Then follow detailed descriptions of the various plumage stages as noted above, colors of soft parts, length of the bird in inches as a rough indication of size, and wing length in millimeters. These descriptions are clearly and meticulously prepared, and are the finest I have seen for South African birds. The geographic ranges appear in two paragraphs, first a detailed description of the range in Natal and Zululand with comments on any recent changes in status, and second the extralimital range. The latter is of great use to the specialist, for there is little agreement among taxonomists on the races of African birds, and a name may mean different things to different workers. The account concludes with a concise paragraph on the ecological requirements of the species, general remarks on its biology, and the date of commencement of the breeding season. Where two or more subspecies of a single species occur, the first receives full treatment while the others are compared to it.

A most attractive feature of this book are the illustrations, 41 color plates showing 70 species, all done by the author. They are portraits of birds in their natural habitat rather than illustrations for identification, and show the same accuracy and care that characterizes Clancey's scientific work. The cost of reproducing these plates was met by voluntary subscriptions from individuals from all over South Africa, and the readers as well as Mr. Clancey are indebted to them. There are also pen and ink sketches of 40 more species scattered through the text, and 17 photographs showing the vegetation types described in the introduction.

The outstanding characteristic of Clancey's work is the care and thoroughness with which it has been done. Not only has he devoted all his time since 1950 to personal research on South African birds, but he has thoroughly studied the relevant literature. His taxonomy is up-to-date, as one would expect from the Secretary of the S.A.O.S. List Committee. There will undoubtedly be disagreement with his recognition of subspecies, for he has often been accused of enthusiastic over-splitting. This criticism is unfair, however. Although I have disagreed with him on several occasions, I have always found his work carefully done, based on all material available, and with a thorough appreciation of the varying ecology of Africa. While there will always be room for legitimate differences in the recognition of subspecies, one is not justified in dismissing Clancey's races without studying the relevant material as closely as he did. In this volume there are some taxonomic notes that should be mentioned. On page 65 Natal is substituted as the type locality for *Plectropterus gambensis niger* Sclater; on page 145 *atra* is used instead of *afra* as the trivial name of the Black Korhaan, an error initiated by Peters (1934); and on page 397 a new race of pipit, *Anthus caffer traylori*, is described from Sul do Save, Portuguese East Africa.

As Clancey specifically states, his book was partially planned to supplement Roberts, and for some information, including measurements other than wings and details of nests and eggs, the reader is referred to that book. Similarly, there are few aids to field identification in Clancey's book, and a copy of Roberts or Mackworth-Praed and Grant is still essential to anyone bird watching in South Africa. Which leads us to the problem of vernacular names, which will plague African ornithology for many years to come. Roberts and Mackworth-Praed and Grant selected their names independently with a large area of disagreement, and Clancey has drawn from both. This will lead to serious misunderstandings, as when Roberts' Cape Reed Warbler is Clancey's Swamp Warbler, and Clancey's African Reed Warbler is Roberts' African Marsh Warbler. The only immediate solution is to learn the scientific names, for even if agreement is reached

in South Africa, there are other sets of names already in use in East and West Africa. I would have preferred to see Roberts' names perpetuated no matter how inappropriate, for his book is a household item throughout southern Africa, and his names are at present the only truly vernacular names.

To sum up, "Birds of Natal and Zululand" is an exeellent book, handsomely illustrated, which aceomplishes the objectives of its author. While it lacks the more leisurely word pictures of the habits of various species to whieh we are aecustomed in our state books, this was outside his intent. Typographieally, it is without any flaw that I have found, and the color reproduction is exeellent. Although written primarily for the resident ornithologist of Natal, it will appeal to anyone with an interest in South Afriean birds.—Melvin A. Traylor.

Geographic Variation in the White-crowned Sparrow, Zonotrichia leucophrys. By Richard C. Banks. University of California Publieations in Zoology, Volume 70. University of California Press, Berkeley and Los Angeles, 1964: 123 pp., many tables and maps. $2.50.

The White-crowned Sparrow, *Zonotrichia leucophrys*, has been studied intensively for at least 25 years. Much of the work has been of a physiologieal nature, particularly with regard to the effeets of light and other environmental factors on the gonadal eyele. These studies contain a certain amount of information on variation among the races of the sparrow, but their emphasis is primarily elsewhere. Now, Banks has published an exeellent and detailed report on the extent of variation in morphological eharacteristies within the species.

In his analysis of 2,103 speeimens, Banks limited himself to museum study skins of breeding White-crowned Sparrows. His method of seleeting populations reduced this number to 1,928 birds, whieh are the subject of his report. The selection of areas to be regarded as containing discrete populations is admittedly arbitrary, and at times difficult for someone who did not actually do the work to understand. In his "Montane Population" category, for example, the map of specimen localities shows no obvious reason for separating the northeastern Utah birds into Wasatch and Uinta populations. The reason may be obvious in the field, and judging by the eareful treatment given the birds throughout the whole report, it probably is.

Banks has arranged the White-crowned Sparrow populations in five major divisions, with 62 individual populations. He has 24 groups in the Paeific Coastal Populations category; 15 in the Montane Populations; 10 in the Alaskan Populations; 5 in the Rocky Mountain Intergrade Populations; and 11 in the Trans-Canadian Populations. Each individual population has been analyzed for the following factors: wing (ehord), tail (data not presented, beeause of too mueh wear and tear), bill, tarsus, middle toe, tarsus/wing ratio, and weight (males only).

Banks finds the best eharacter for separating *Zonotrichia leucophrys nuttalli* from *Z. l. pugatensis* to be the longer tarsus of the formcr. Color differences he found to be largely a result of differential wear of the feathers, resulting from a less complete nuptial molt in *nuttalli*. He considers both *Z. l. oriantha* Oberholser and *Z. l. nigrilora* Todd to be indistinguishable from *Z. l. leucophrys*.

An interesting proposal is made on page 43 regarding the sexual dimorphism of wing length. Banks notes that the male, which has longer wings that the female, patrols the territory, and also flies considerable distances when alarmed, whereas the female stays near the nest or disappears into nearby thickets when disturbed. By implication, he suggests that the longer wing of the male is associated with this greatcr flying distance,

just as Averill (1920, *Auk*, 37:572–579) in his study of related species or races of North American birds found longer wings in migratory groups and rounded wings in sedentary groups. I doubt very much that an additional 6- to 10-mile flight each day for 5 or 6 weeks would be reflected in a discernible difference in wing length—and 6 miles is all that would be added if the male were flushed and flew 300 yards every half hour of a 16-hour day. Perhaps the origin of the variation could be found in distance or duration of migratory flight. This information might be obtained from banding files.

My only other adverse comment is on a deficiency. The publication is so long, and contains so much interesting and useful material, that it needs an index. Aside from this drawback, "Geographic Variation in the White-crowned Sparrow" is a valuable addition to our information on a frequently studied laboratory and field bird.—Ormsby Annan.

John James Audubon. By Alice Ford. University of Oklahoma Press, Norman, Oklahoma, 1964: 6½ × 9½ in., xiv + 488 pp., 24 illus. by John James Audubon and others, and 16 photos. $7.95.

Earlier books by Alice Ford—"Audubon's Animals," "Audubon's Butterflies and Other Studies," and "Bird Biographies of Audubon"—did much to widen appreciation of Audubon's varied talents as an artist and as a reporter of wildlife in the first half of the nineteenth century. Now through careful research in France and England as well as in the United States, Miss Ford has discovered some new, well-documented facts about the birth and life of the man who has become a household name in the world of birds and conservation. She has dispelled many popular notions about the great artist and records his prolonged and often discouraging efforts to publish his "The Birds of America." It is doubtful if any really important facts about Audubon's life will be added to those contained in this biography and in Francis H. Herrick's "Audubon, the Naturalist," that indispensible biography published in 1917.

John James Audubon was the natural son of Captain Jean Audubon and Mlle. Rabine. Mlle. Rabine, the daughter of a French farm worker, traveled as a chambermaid on the same ship with Audubon's father to Santo Domingo in 1783. She died on his plantation there a few months after their son was born. When trouble with slaves made Santo Domingo dangerous for whites, Captain Audubon returned to France with his young son and his daughter, Rose, who was only half white, but whose skin was so pale that it was not safe to leave her on the island. Both children were finally adopted by the captain and his only legal wife, who remained childless.

At the age of eighteen, young Audubon was sent to manage Audubon properties in America. He married Lucy Blakewell in April, 1808. Lucy was a lovely, cultured young lady who shared with great courage the difficulties of physical hardships and financial crises that continually plagued the Audubons.

While still a child, Audubon displayed an interest in birds and began to draw them. He had little formal teaching in art but as he continued to paint and observe, his skill increased. His profound interest in birds and love of the wilderness deepened as time went on and contributed heavily toward his succession of business failures. With the help of his wife and kind friends, he managed to keep himself and his family alive (though two small daughters died) through an endless number of vicissitudes that would have killed or at least completely discouraged a lesser man. He persisted in his collection of birds, in painting them, and writing notes about them.

In 1826 Audubon, with a great portfolio containing more than 400 drawings of birds, sailed from New Orleans for England. His head was filled with the dream of publish-

ing the drawings full size and with the color perfectly reproduced. His discouragements interspersed with small successes were almost intolerably exhausting. In spite of constant financial worries added to difficulties with engravers, the vast project was completed in 12 years.

During the years that remained to Audubon, he continued to paint birds, began work on "The Viviparus Quadrupeds," and made many journeys, the last taking him on a collecting trip into the Upper Missouri in 1843. In all his later work he was assisted by Lucy, their sons, Rev. John Bachman of Charleston, and his two daughters both of whom became Audubon's daughters-in-law, and many others.

Miss Ford calls Audubon "the greatest delineator of American birds," a statement nobody can challenge. Her thorough research has resulted in a biography which is scholarly in its bibliography, in its footnotes, and in its location of many Audubon materials. This can truly be termed a definitive biography. It reveals Audubon's tremendous physical stamina and his inflexible determination to carry his work as a painter and observer of birds to a successful conclusion.

The book is less successful in presenting the enthusiasm and exuberance of Audubon's spirit and his devotion to the wilderness and appreciation of wildlife as we know these qualities from his "Journal" and his accounts of birds and mammals. Ornithologists will regret the fact that such mistakes as the incorrect labeling of the Audubon drawing of a Red-shouldered Hawk and also the slip which resulted in a "black-haired grosbeak" were not caught by a proofreader.—Helen G. Cruickshank.

Argen the Gull. By Franklin Russell. Alfred A. Knopf, New York, 1964: 5½ × 8⅜ in., 239 pp., 9 photos. $4.95.

The protagonist in Franklin Russell's "Argen the Gull" is both flexible and variable, lending himself easily to the author's imaginative pen. The gull family is distinguished by its very lack of specialization—gulls fly, swim, and walk equally well. *Larus argentatus*, the Herring Gull, provides a closer focus on the versatility of the group.

The inexorability of death to the weak is one of the more striking themes in Argen's life. Impassively, the living feed upon the dead, and life continues. The rainstorm that washes nestlings from their ledges, that swells into rivers whose eddies clot with the bodies of drowned rabbits, insects, Robins—this rainstorm throws up new sources of food for the animal life that has survived. A harsh winter starves the gull colony, and foxes prowl the beaches to devour the birds which drop from want of food.

Russell's images are often as fresh and clear as the morning mists that move in off the sea, bringing ocean birds. In describing a "black cap" of thousands of murres on a small island, we see them "now much more distinct and in places boiling up blackly into the air and splitting into specks of motion which formed into lines and wound sinuously away from the island."

Unfortunately, his style is wobbly, and we too often meet with crippled analogies, endless detail that could easily have been pruned, and awkward, uncomfortable descriptions.

Nine evocative photographs by Russell illustrate stages in Argen's life, although it is rather unfair of him to use a kittiwake as a photographic stand-in for Argen (last photograph in the series) and not say so. Russell is talented and energetic; more the pity, then, that careless editing allowed too many imperfections to go into print.—Billie Jean Lancaster.

Bird Songs. By Norma Stillwell. Doubleday and Company, Inc., Garden City, New York, 1964: 6½ × 8½ in., xix + 194 pp., 16 photos. $4.95.

This slim book, introduced by Dr. Peter Paul Kellogg, Professor of Ornithology and Biological Acoustics, Cornell University, is an account of two people who determined to contribute in their retirement years to our knowledge of bird songs. Norma Stillwell tells a straightforward tale of how she and Jerry Stillwell began recording bird songs and followed through until three fine volumes of bird songs were produced. To all those who enjoy field work of any kind, "Bird Songs" is a book to open with anticipation which is delightfully fulfilled. One follows the Stillwells through their early difficulties with their recording equipment and also with their trailer transportation. The pursuit of bird songs led the Stillwells to the far corners of this country as they sought out new species whose songs they could record. End-paper maps of the United States indicate key areas for many of the species whose songs were collected. Photographs of their equipment, of the Stillwells in action, and some of the places where they worked add interest. This is a story of successful achievement of a goal which should be an inspiration to others who, rather late in life, wish to take up a new and useful project that can lead to an extension of our knowledge of wildlife.—Helen G. Cruickshank.

The Oxford Book of Birds. By Bruce Campbell. Oxford University Press, London, 1964: 7 × 9½ in., xvi + 207 pp., 96 col. pls. by Donald Watson, 9 line drawings. $8.00.

There are numerous books on English birds, and one wonders what niche a new one might fill. It speaks well for ornithology in England that so many publishers in that country, as in our own, are able to find a receptive market for books with so much overlapping content.

This book is one of a series published by Oxford University Press on various animal groups. Its author proposes to encourage an interest in the identification of birds and in their conservation, and "to show readers of any age the great range of bird life to be found in the British Isles. . . ."

The book consists largely of species accounts. Of 452 species discussed, 307 are refreshingly illustrated on 96 colored plates that show the sex, age, and seasonal differences. A seven-page introduction to the species accounts provides a classification and a descriptive paragraph of each of the orders and families of British birds. Each account describes the species and offers additional information on identification clues, distribution, food, calls, nesting, behavior, migration, and flight. With the numerals 1 to 12 representing the months of the year, the book employs a concise system to show the status of each species in the British Isles. Numerals underscored, in bold type, and in parentheses tell the breeding time of each species, its song period, months during which it can be seen in Britain, and whether it is a regular or occasional visitor.

Following the species accounts at the end of the book are short, two-page sections on "Special Features of the Bird's Anatomy," "Flight," "Behaviour and Breeding," "Migrations, Numbers, and Age." A list of suggested readings and a species index conclude the book.—Douglas A. Lancaster.

This issue of *The Wilson Bulletin* was published on 1 June 1965

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The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 77, No. 3, SEPTEMBER 1965 PAGES 215–324

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THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be ordered from the Treasurer. Special prices will be quoted for quantity orders.

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Second class postage paid at Lawrence, Kansas, U.S.A. Additional entry at Ann Arbor, Mich.

PRINTED IN U.S.A. The Allen Press, Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by the Wilson Ornithological Society

VOL. 77. NO. 3 SEPTEMBER 1965 Pages 215–324

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THE ROOSTING BEHAVIOR OF THE RED-WINGED BLACKBIRD IN THE SOUTHERN UNITED STATES

Brooke Meanley

A study of the roosting behavior of the Red-winged Blackbird (*Agelaius phoeniceus*) and associated species in southern United States was made during the 14-year period of 1950 through a part of 1964. Observations were made chiefly in the lower Mississippi Valley region of Arkansas, Mississippi, and Louisiana, and in the Atlantic Coastal Plain area from Chesapeake Bay to Savannah, Georgia. Other studies of the roosting behavior of blackbirds in the South have been made by Dunbar (1952), Neff and Meanley (1952, 1957*a*, 1957*b*), Meanley (1956), and Meanley and Webb (1960, 1961).

Red-winged Blackbirds and several other icterids form roosts during every month of the year. The size of roosts varies considerably from season to season; the low point in numbers is reached during the breeding season when most of the population is dispersed. Most large rural roosting populations in southeastern United States are composed of several species, including Red-winged Blackbirds, Common Grackles (*Quiscalus quiscula*), Brown-headed Cowbirds (*Molothrus ater*), and Starlings (*Sturnus vulgaris*). In coastal areas, Boat-tailed Grackles (*Cassidix mexicanus*) also are found. During the winter half of the year, Rusty Blackbirds (*Euphagus carolinus*) and sometimes Robins (*Turdus migratorius*) join these aggregations.

METHODS

Roosts were observed continuously throughout the year on the Arkansas Grand Prairie in Arkansas and Prairie Counties, during the period 1950 through 1955. Nearly continuous observations were made at a tidal marsh roost along the Patuxent River, Anne Arundel County, Maryland, from 1958 through 1963. Observations for a period of at least one month were made at roosts located near Lobdell, West Baton Rouge Parish, Louisiana; Hick's Station, St. Francis County, Arkansas; and in the Dismal Swamp, Camden County, North Carolina, and Norfolk County, Virginia. Numerous other roosts were observed for shorter periods of time.

Information about species composition, sex and age ratios, and molt of roosting birds was obtained by trapping, netting, collecting, and making observations at roosts; information on segregation, density, height of roosting, and other aspects of roosting behavior were obtained by using a headlight in roosts at night.

Estimates of the number of birds in roosts were obtained by one of several

methods. In a small roost (up to 20,000 birds) a total count was made as the birds moved toward the roost in established flightlines. Larger roosting populations were estimated in the following manner: (a) by making block counts on a time basis as birds passed between two points along a roost flightline; (b) by taking a series of representative photographs at regular intervals during the evening flight; and (c) by making density counts in quadrats at night; this procedure is feasible in ground roosts in rice (*Oryza sativa*) stubbles and in weathered-down cattail (*Typha* sp.) marshes.

Several specimens collected at roosts were identified to subspecies by Allen J. Duvall of the U.S. Fish and Wildlife Service.

DISTRIBUTION OF ROOSTING POPULATIONS AND COMPOSITION OF ROOSTS

The greatest concentrations of Red-winged Blackbirds in the southern states occur in the Coastal Plain Province in or near major rain-producing areas (Kalmbach, 1937; Neff and Meanley, 1957a; Meanley and Webb, 1961). Within this vast lowland region, the major population centers include the rice belts and river deltas of Arkansas, Louisiana, and Mississippi; the Gulf Coast marshes; the Virginia–Carolina peanut belt; the South Atlantic coastal marshes; and the lower Florida peninsula. Common Grackles, Brown-headed Cowbirds, and Starlings also occur in large numbers in some of these coastal plain areas, as well as in the Piedmont and Ridge and Valley provinces where the Red-winged Blackbird is less numerous.

The composition of roosting blackbird and Starling populations varies considerably. For example, in the Southeast in winter, Red-winged Blackbirds occur in greater numbers farther south and nearer the coast than do Common Grackles. Therefore, many tidal marsh roosts contain only Red-winged Blackbirds. Conversely, some winter roosts in the Piedmont Province do not contain Red-winged Blackbirds, but are composed of Common Grackles, Brown-headed Cowbirds, Rusty Blackbirds, and Starlings.

In Arkansas County, Arkansas, Common Grackles formed an estimated 80 per cent of the population in a large winter roost in the bottomland forest along the White River; while a winter roost located on the Grand Prairie in the same county contained an estimated 70 per cent Red-winged Blackbirds. The difference in composition probably is related to the food habits of these two species. The Red-winged Blackbird is essentially a bird of the prairie, feeding mostly on grain and weed seeds in winter, while the Common Grackle sometimes feeds to a great extent on acorn (*Quercus* sp.) and hackberry (*Celtis* sp.) mast found in the bottomland forest.

Most roosts undergo a marked change in composition with the advent of

migration. Roosts on the Arkansas Grand Prairie that were composed of birds of several age classes and both sexes of four species in late February 1951, contained mostly female Red-winged Blackbirds one month later.

Several different populations and geographic races may be represented in a roosting population. Banding data show that Arkansas roosts containing several species of blackbirds in late February are composed of both birds that breed locally (approximately 20 per cent) and birds that breed in the North-Central states (approximately 80 per cent). Specimens of three races of Red-winged Blackbirds were collected at one roost.

ANNUAL ROOSTING CYCLE

Late summer roosting.—With the termination of the nesting season and the onset of molt in July, resident Red-winged Blackbirds congregate mainly in wetland habitat, such as tidal marshes, nontidal marshes, and rice fields, where they not only roost but spend part of the day feeding and loafing. The size of roosting populations at this time is relatively small (an estimated 5,000 roosted at the Patuxent River marsh, Maryland, 9 July 1962). There is a marked increase in numbers after the first of August with a peak usually some time between the first of September and the first of October. With the completion of molt in late September, there is a gradual exodus from roosts, except from those in the Gulf Coast area.

Fall roosting.—Fall roosts are of several types: (a) those used for comparatively short periods by transient birds en route from breeding to wintering ground; (b) those used as late summer roosts that continue to be used throughout the fall and sometimes into the winter (many such roosts occur in tidal marshes of the South Atlantic coast, and in the Gulf Coast marshes, where the Gulf Coast Red-winged Blackbird (*Agelaius phoeniceus littoralis*) is resident the year around); and (c) roosts formed in the fall that continue to be used through the winter and early spring.

Some fall roosts may contain segments of both the outgoing resident breeding population and the incoming winter population.

Winter roosting.—On the wintering ground, roosts are formed which vary in size from a handful of birds to several million (Sykes et al., 1961). Such roosts may have been formed in the fall or in the early winter. These winter roosts usually are occupied over a longer period of time and are larger than other seasonal roosts. Some roosts may reach their greatest size in midwinter; while others may reach peak size in late winter. Most roosts on the Arkansas Grand Prairie reach a peak during the last week in February or the first week in March.

Spring roosting.—Most of the large winter roosts on the Arkansas Grand

Prairie continue in use until mid-April. Band-recovery information indicates that these roosts are occupied in the early spring by resident breeding birds, and by breeding birds from the North-Central states. In late February and early March, resident adult male Red-winged Blackbirds occupied breeding territories near roosts, and usually would return to communal roosts on cold nights. Birds occupying these roosts in April were mainly female and subadult male Red-winged Blackbirds. The roost at Slovac, Arkansas, contained an estimated 10.000 female redwings as late as 30 April 1951. In more northern latitudes. spring-transient roosts often are formed in old fall roost sites that were unoccupied during the winter.

Nesting season.—Red-winged Blackbirds occupying roosts during the earlier part of the nesting season on the Arkansas Grand Prairie were observed to be predominantly subadult males. A roost located at Stuttgart, Arkansas, on 15 May 1951, contained an estimated 15,000 birds, mostly of this age class. Observations indicated that subadult males were predominant throughout the period that the roost was in use (until late June). In a sample of 30 birds collected at this roost, 26 were subadult males, 1 was an adult male, and 3 were subadult females.

An estimated 3.000 Red-winged Blackbirds and 1,000 Boat-tailed Grackles were observed roosting together in a sawgrass (*Cladium jamaicense*) marsh 10 miles south of Fellsmere, Indian River County, Florida, on 7 May 1964. Both sexes of the two species were represented. Ages were not determined.

ROOST LOCATIONS

The general locality in which large roosts are located is probably influenced by food supply. As an example, 15 roosts, each containing an estimated one million or more blackbirds and Starlings, were located in Arkansas in the winter of 1962–63. All of these roosts were in or within 25 miles of the rice belt. The precise location of a roost is determined by several factors, chief of which is the character of the habitat. Dense cover appears to be important. A wetland situation is usually chosen by Red-winged Blackbirds.

The importance of water in a roost site can be demonstrated by the preference of roosting blackbirds for flooded rice fields in the lower Mississippi Valley. Rice is planted in water which is maintained at a depth of 4 to 8 inches during the growing season. When the fields are drained 2 weeks before harvest. birds that have been roosting in such fields usually move to a roost in greener fields with standing water.

Some roosts are located in dry sites. Favorite dry land sites are deciduous thickets. coniferous stands, canebrakes (*Arundinaria*), and sugarcane fields. Although some roost sites may be used year after year, in areas where many sites are available birds may shift about from year to year. During eight

FIG. 1. Pocosin roost cover type. Pinetown, Beaufort County, North Carolina, January 1960.

winters of observation on the Arkansas Grand Prairie, birds roosted in five different sites, all within a 15-mile square area. Where extensive areas of similar cover occur, such as in the great pocosin bogs of eastern North Carolina. birds may relocate their roost several times during the course of a single winter. Some roost sites are used the year around or most of the year, but seldom are occupied by the same population at all seasons.

Atlantic and Gulf Coast marshes.—Most of the roosts in the Coastal Plain Province are located in marshes and swamps. Many forms of emergent vegetation provide excellent roost cover in marshes. In the Chesapeake Bay region the plants most commonly used are reed (*Phragmites communis*), cattail, and big cordgrass (*Spartina cynosuroides*). Reed averages 10 feet in height and big cordgrass about 7 feet.

Red-winged Blackbirds also may roost in a dense marsh mixture of several species of plants. One such roosting site in the Patuxent River marsh, Maryland, was composed of a rank mixture of wild rice (*Zizania aquatica*), water hemp (*Acnida cannabina,*) and beggar-tick (*Bidens laevis*).

In marshes of the South Carolina–Georgia low country, giant cutgrass

FIG. 2. Deciduous thicket roost type. Prairie County, Arkansas, February 1951. Branches of low tree broken by the weight of roosting birds.

(*Zizaniopsis miliacea*), reaching a height of 6–7 feet, produces one of the most important roosting habitats. Extensive stands of this plant, known as "White Marsh" because of the blanched appearance in winter, grow in the fresh and slightly brackish tidal zones of coastal rivers.

In the Louisiana gulf coast marshes, favorite roosting sites are reed (known locally as roseau cane), southern bulrush (*Scirpus californicus*), and giant cut-grass.

North Carolina pocosins.—In much of the Outer Coastal Plain of North Carolina there are vast pine bog wilderness areas known as pocosins (Fig. 1). Pond pine (*Pinus serotina*) is the dominant overstory, while various broad-leaved evergreen shrubs and vines such as bays (*Persia borbonia*) and (*Gordonia lasilanthus*), titi (*Cyrilla racemiflora*), gallberry (*Ilex glabra*), and catbrier (*Smilax laurifolia*) form the understory. The largest winter roosts on the Atlantic Coastal Plain are located in pocosins. Such roosts are often remote and nearly inaccessible because of the jungle-like understory.

Mississippi River delta.— The largest winter concentration of blackbirds found in the United States is in the Mississippi River delta area of Arkansas, Louisiana, and Mississippi. Deciduous thickets (Fig. 2) are the main roosting cover used by wintering blackbirds, and most of these are swampy. Other

habitats include the canebrakes and willow bars along the Mississippi, Arkansas, and other rivers; and cattail and giant cut-grass marshes bordering old riverbed lakes or oxbows.

In the southeastern Louisiana sugar belt, sugarcane fields are an important roosting site in late fall. After the fields are harvested in November and December, the birds move into characteristic winter habitats. In the south Florida sugar belt bordering the southern rim of Lake Okeechobee, sugarcane also is an important roost habitat.

Mid-South rice belt.—In the rice belt of Arkansas and Mississippi during late summer and early fall, most of the roosts are located in domestic rice fields. Rice fields are veritable man-made marshes with plants averaging about 5 feet high. The fields are used until the harvest is completed in late October or early November. In southwestern Louisiana and the contiguous coastal prairie of Texas, late summer roosts occur mainly in rice fields and coastal marshes.

The most unusual roost site that I have ever seen was a rice stubble that had been flattened by severe winter weather and was completely coated with a sheet of ice. Several hundred thousand blackbirds of five species were using the location, and were roosting on the ice. This was a temporary situation as the ice soon thawed.

Southern Piedmont.—Although fewer Red-winged Blackbirds occur in the Piedmont than in the Coastal Plain, some of the highland roosts contain large numbers of this species. In a roost at Clemson, South Carolina, located in the upper Piedmont, Red-winged Blackbirds and other blackbirds roosted in a bamboo (*Phyllostachys* sp.) thicket. On the Fall Line at Montgomery, Alabama, and in the lower Piedmont at Auburn, Red-winged Blackbirds and other icterids and Starlings also roosted in bamboo. Coniferous stands and deciduous thickets sometimes are used as roost sites.

MOVEMENTS TO AND FROM ROOSTS

Blackbirds move out of roosts each morning at about dawn or shortly after and return in the evening, usually before sunset. Regardless of the location of the roost most blackbirds apparently prefer to "get out and get going" before settling down to feed. Often they disperse over a wide area and begin feeding at a considerable distance from the roost. Some birds may travel many miles from the starting point in the course of a day's feeding activity, although the same kind and abundance of food may be available less than a mile from the roost. In Texas Red-winged Blackbirds and other icterids were observed to fly 46 and 52 miles, respectively, from two coastal marsh roosts to their feeding ground in the rice belt. Although a ripen-

ing Arkansas rice field was used as a roost by an estimated one-half million Red-winged Blackbirds, fewer than 100 birds fed there each day. However, when birds roost in the earliest or latest ripening rice field in an area, considerable feeding may take place at the roost.

The return trip to the roost may be made by a series of short movements, sometimes beginning by midafternoon or several hours before arrival at the roost, but birds feeding at a great distance from the roost in late afternoon must make an extended flight to reach the roost by sundown or nightfall.

On cloudy days, blackbirds feed closer to the roost, and were observed to move into the roost 15 to 30 minutes earlier than on sunny days. On a cloudy day, 4 February 1959, at a point 10 miles from a roost in the Dismal Swamp, Virginia and North Carolina, the main flight to the roost was from 4:45 to 5.15 PM. The following evening was sunny and the main flight at this same point was between 5:10 and 5:40 PM.

In flying to and from roosts, birds usually follow the same route. The route of travel is generally along natural landmarks, such as a drainage system, hedgerows, or bushy field borders, that lead in the direction of the roost.

The composition of a roost flight (or flightline) may depend upon the time of day, distance from the roost, and the composition of feeding groups. Some species precede others to a roost. The later in the day and the closer to the roost, the more integrated the flight may become. In the Patuxent River Valley, Maryland, subadult male Red-winged Blackbirds were always the first to arrive at late summer roosts. These were followed usually by females and juveniles. Adult males were sporadic in their time of arrival. Red-winged Blackbirds were followed by Bobolinks (*Dolichonyx oryzivorus*), Starlings, Common Grackles, and finally cowbirds. Red-winged Blackbirds arrived over a longer period of time than the other species.

Different species fly in characteristic formation all the way to some roosts and at least part of the way to all roosts. The flight pattern of Common Grackles is usually a long line. Other species when flying alone tend to fly more in a broad front, but in a long line when integrated.

Stratification in a roost flight was observed where birds were flying downstream to a river marsh roost. Bobolinks flew at the greatest elevations and in smaller flocks than other species. Next in order of height were Starlings, grackles, cowbirds, and Red-winged Blackbirds (closest to the ground). The later the flight, the closer to the ground all of the birds fly until the last birds flying toward the roost at dusk just skim over the top of the marsh vegetation. At 10 miles from a roost in southwestern Louisiana, birds were flying at an estimated 1,000 to 1,500 feet elevation over the rice fields toward their roost in the marsh.

At virtually all roosts, a small percentage of the roosting population arrives after dusk. Some of these birds strike telephone wires or other obstacles that are located near the roost. This often results in considerable mortality.

Arrival at the roost.—At a Patuxent River marsh roost in Maryland, birds entered over a longer period of time in summer than in winter. For example, an estimated 100,000 birds entered the roost during a period of about 2 hours in July, while in November approximately the same number arrived within a half-hour.

Birds began arriving at the roost about one hour before sunset in late July 1961. Birds arrived at this roost at about the same time in both November and December. one-half hour before sunset.

On bright sunny evenings in early spring, some early arrivals at a roost have been observed to occupy a prominent perch in the roost area, chorus for a short while, and then depart for a brief period of feeding somewhere about the periphery of the roost, or as far as 2 or 3 miles away. At the Patuxent marsh, some Red-winged Blackbirds were observed to bathe shortly after arrival at the roost.

In late winter, just before the large roosts begin to break up or diminish in size, birds are sometimes quite unsettled when they arrive. With no apparent provocation, they fly up and circle about the roost many times. In a 14-acre wooded "island" roost on the Arkansas Grand Prairie I have seen the entire population of an estimated 20 million birds fly up from the roost, wheel around, and return. This performance was repeated several times before the birds settled down for the evening. The causes of disturbance at roosts are many. Hunters shooting at ducks near a tidal marsh roost in the Chesapeake Bay region kept the birds from settling down until dark. Birds of prey coursing about roosts may do the same. Strong gusts of wind may also disturb the birds.

On warm, sunny evenings as the birds settle down they begin a chorus that may continue in part through much of the night, and especially on warm moonlight nights. Such chorusing is especially marked at large, early spring roosts just before and during the period the roosts diminish in size. By contrast, on stormy nights the birds settle down quickly and remain quiet.

Morning exodus.—The exodus of a large roosting population is of shorter duration than the movement into the roost. The departure from a cattail marsh roost at Hazen, Arkansas, was witnessed on the cloudy morning of 10 February 1952. The roosting population was estimated at about one-half million birds, and was composed of several species of Icteridae. The first activity noted at the roost was at about 6:45 AM (CST), when grackles began to chorus. Shortly after the chorus began, small flocks flew up and out of

the roost, circled, and returned. Following this maneuver, the birds began leaving the roost shortly after 7:00. The complete departure took only about one-half hour, the birds moving out in large flocks and completely leaving the roost area.

At a canebrake roost near Baton Rouge, Lousiana, the morning exodus was observed on 3 January 1963. The temperature was 38 F; sunrise was at 7:02 AM (CST); the weather was clear. An estimated 10 million blackbirds and Starlings, and 1 million Robins were roosting in the canebrake. The first activity noted was the morning chorus, which began at about 6:05. At 6:35 some of the blackbirds began moving out of the cane understory where they roosted and up into the overstory of scattered hardwoods. The Robins also began to leave the roost. By 6:38, the first blackbirds began to leave the roost. The main exodus was from 6:40 to 7:03 (sunrise). All birds had come up out of the cane roosting cover by 6:55, but about 50 per cent were still in the hardwood overstory. Starlings appeared to be the last to leave the roost. The entire roost was clear of blackbirds, Starlings, and Robins by 7:10.

ROOSTING BEHAVIOR

Segregation.—Some segments of the population are segregated in virtually all roosts. Segregation is the result of: (a) birds feeding in segregated flocks during the day and returning to the roost the same way; (b) flocks of birds of one species or one sex returning to a favorite section of the roost each evening; and (c) stratification in the roost. In a large roost on the Arkansas Grand Prairie, several thousand female Red-winged Blackbirds roosted every night for three consecutive winters in the same low brushy vegetation in the same section of the roost. In two Arkansas roosts in deciduous thickets, Starlings roosted highest in the trees; then came grackles and male Red-winged Blackbirds together; below them were cowbirds and female Red-winged Blackbirds; lowest were Rusty Blackbirds and more female Red-winged Blackbirds.

Stratification also was observed in a marsh roost near Hazen, Arkansas. Three species of plants were predominant in the marsh: cattails (*Typha latifolia*), which were standing erect; a sedge (*Carex hyalinolepis*), most of the plants of which were partly blown over; and smartweed (*Polygonum* sp.), which was lying prostrate over the water forming a mat. All species and sexes and ages were roosting in the cattails; grackles and male Red-winged Blackbirds were roosting in the blown-over sedge; and only female Red-winged Blackbirds were roosting on the smartweed mat. The feet, tail, and lower underparts of many of the female red-winged blackbirds were in the water.

In an Arkansas cattail roost, grackles were observed to roost in the more

open part of the roost while Red-winged Blackbirds roosted in a part of the marsh where there was a scattering of willows, or in the more shrubby or wooded part of the marsh, and along brushy edges.

Around the periphery of many large roosts where observations have been made, there have been small groups of roosting birds, usually of one species and often of one sex. Such peripheral roosting is especially characteristic of female Red-winged Blackbirds and Rusty Blackbirds. Brewer's Blackbirds often perch near the edges of large roosts until it is time to bed down, then they move out in broom-sedge fields or rice stubble to roost by themselves. Robins in roosts generally separate themselves from blackbirds. In a canebrake near Baton Rouge, Louisiana, Robins roosted mainly along the edge of the roost, although a few were observed roosting with female Red-winged Blackbirds.

Height and density of roosting.—As noted in the foregoing discussion, blackbirds may roost on partly submerged vegetation in a marsh, on the ground in grassy fields, in branches of trees, or in various other sites. Birds roosting in reed cane, which average about 10 feet high in some marshes, usually perch within 1 or 2 feet of the water. Rice plants average about 5 feet high, and blackbirds were observed perching near the base of the stalk, usually within 6 inches or a foot of the water. In deciduous thickets with extremely high bird densities, birds by necessity are forced to roost in all available space; they may be perched at elevations of 1 foot to 30 feet or more.

In high-density roosts in deciduous thickets on the Arkansas Grand Prairie, Red-winged Blackbirds roosted along branches at an average of about three birds per foot. Where a flock of an estimated 5,000 female Red-winged Blackbirds was roosting on a mat of aquatic vegetation in a pond near Stuttgart, Arkansas, I caught from three to 10 birds with each thrust of a long-handled hoop net having a diameter of 23 inches.

SUMMARY

This report concerns the roosting behavior of the Red-winged blackbird and associated species; and is based on observations made over a 14-year period mainly in the Southern United States.

The greatest concentrations of Red-winged Blaekbirds in the southern states occur in the Coastal Plain Province in or near major grain growing regions.

Roosts are formed during every month of the year. The largest roosts are usually found in winter; the smallest during the breeding season. Composition of roosts may vary from place to place and from season to season.

The general locality in whieh roosts are found is probably influenced by food supply. The precise location is determined by the character of the habitat. Wetland situations are preferred by Red-winged Blackbirds. Most of the roosts in the Coastal Plain Province are located in marshes and swamps. Rice fields are important in the southern rice-

producing area. Coniferous stands and bamboo are frequently used in the Piedmont Province.

Blackbirds move out of roosts each morning at about dawn or shortly after, and return in the evening usually before sunset. Some birds may travel 35 miles or more from the starting point in the course of a day's feeding activity. On cloudy days blackbirds move into the roost earlier than on sunny days. At a Maryland roost subadult male Red-winged Blackbirds were the first to arrive at the roost. Females and then juveniles followed. Adult males were sporadic in their time of arrival. Stratification in a roost flight was observed where birds were flying downstream to a river marsh roost. Bobolinks flew at the greatest elevations; next in order of height were Starlings, Common Grackles, Brown-headed Cowbirds, and Red-winged Blackbirds. The exodus of a large roosting population is usually of shorter duration that the movement into the roost.

In virtually all roosts some segments of the population are segregated. Stratification by species and by sexes of some species has been noted in roosts. Blackbirds may roost on partly submerged vegetation in a marsh, on the ground in grassy fields, in branches of trees, or in various other sites. In deciduous thickets with high bird densities they may roost at elevations of 1 foot to 30 feet or more. In one Arkansas roost Red-winged Blackbirds were roosting along branches at an average of about three birds per foot.

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FLIGHT BEHAVIOR OF THE RED-FOOTED BOOBY

Jared Verner

From 14 February to 9 May 1958, a study of the breeding biology of the Red-footed Booby (*Sula s. sula*) was undertaken at Half Moon Cay, 50 miles east of Belize, British Honduras. The results of that study have been presented in an earlier paper (Verner, 1961); the purpose of the present paper is to report observations on various aspects of flight and flocking behavior in this species.

To become airborne, the boobies normally launch into the wind from an elevated perch; they also take flight from the ground with ease when heading into a wind. When there is no wind, however, they fly from the ground only with difficulty, half running and half flying for several feet before finally achieving full flight. To fly from the surface of the water they jump forward suddenly into the wind by thrusting backward with both feet simultaneously, in the manner of pelicans.

Ordinarily the boobies alternate a few flaps of the wings with short glides but were occasionally seen to glide more than a mile without flapping. They display great agility in gliding long distances above the surface of the sea, just clearing the crest of each wave without stroking their wings, even when there is relatively little perceptible wind on shore. Their flock patterns have been described as lines and wedges (Maynard, 1889), and Gifford (1913) stated that "members of a flock are practically synchronous in every action." My observations of flocks near the breeding colony at Half Moon Cay, on the other hand, indicate that disorder was the rule. Rarely, flocks formed irregular ranks or files that were maintained at most only a few seconds. The composition of flocks was very dynamic, individuals leaving and joining groups and flocks splitting or combining frequently. Perfect synchrony in the flap–glide actions of members of a flock was sporadic at best, and the extent of asynchrony increased with increasing flock size.

FLIGHT TO AND FROM THE CAY

Each day great numbers of boobies left the colony early in the morning, spent the day fishing, and returned to the colony in the evening. Night flying occurred but probably not to an appreciable extent (cf. Sharpe, 1904). The main fishing grounds apparently lay to the east of the cay, since birds *always* departed toward, and returned from, the east. If there was sufficient wind in the morning to create an updraft against the vegetation at the windward side of the island, the boobies congregated in the updraft as a soaring group from which individuals and smaller groups departed for the day's

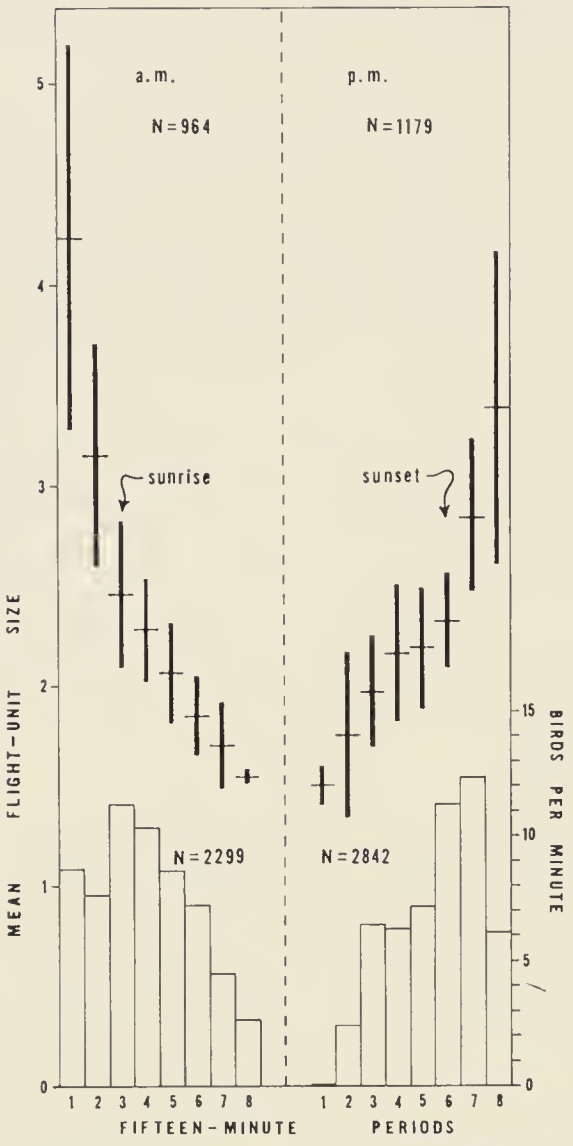

FIG. 1. Mean sizes of flight units (left scale) during each count period are shown above with two standard errors plotted on each side of the mean. Flight density (right scale) is shown in the lower histogram. The number of flight units is indicated above and the number of birds below. Results for AM are based on three days' records, combined on the basis of sunrise time; those for PM are based on four days' counts combined by sunset time.

fishing. The position of this soaring group shifted with changes in wind direction but had no influence on the final easterly orientation of departing birds. The departure began before daylight, reached a peak within 10 minutes of sunrise (the exact time varying with sky and wind conditions), and was nearly completed by an hour after sunrise (Fig. 1).

Although boobies flew to and from the colony all day, movement was negligible from an hour after sunrise to an hour before sunset. In 100 minutes of observing between 1050 and 1200 on 2 days, 44 birds left the colony and two entered it; and from 1400 to 1600 on one afternoon only

17 birds entered the colony and none left. The mean size of flight units during these periods was 1.4 ± 0.14 ($N = 44$) (the term flight unit being used here designates any solitary bird or group of birds). The largest flight unit noted consisted of 36 birds leaving the colony just before daylight on 5 March. Mean flight-unit size in the early morning was 2.4 ± 0.07 ($N = 964$) and that in late evening was 2.4 ± 0.06 ($N = 1{,}179$).

Examination of Figure 1 reveals that the mean flight-unit size decreased steadily during the morning and increased steadily during the evening. The same, however, was not true of the number of birds per minute (flight density) passing the point of observation. Flight-unit size in each succeeding 15-minute count period was independent of that in the preceding count period, since new birds, hence entirely new flight units, were passing continuously.

Applying the Spearman Rank Correlation Coefficient (r_s) to combined results of morning and evening count periods indicates a significant correlation ($r_s = 0.78$, $P < 0.01$) between mean flight-unit size and the number of birds passing per minute after sunrise and before sunset. Before sunrise and after sunset (periods including sunrise and sunset were grouped with this ranking), however, there is no positive correlation ($r_s = -0.60$) between flight-unit size and flight density. At the same time, there is a strong correlation ($r_s = 1.00$) between increasing flight-unit size and decreasing light intensity, indicating that darkness increases the birds' tendencies to aggregate regardless of their density. This phenomenon suggests that, after dark, groups of birds may navigate more effectively than individuals, making it more advantageous to form groups after dark.

FRIGATEBIRDS AND FLYING BOOBIES

About 20 pairs of Magnificent Frigatebirds (*Fregata magnificens*) nested within the booby colony. The piratic habits of this species are well known, and I observed numerous aerial attacks of the frigatebirds on boobies returning to the colony from a fishing foray. Boobies under attack screeched loudly in a raucous voice and attempted to outmaneuver the larger birds—often diving at great speeds in amongst the treetops. Frequently the frigatebirds seized a wing tip or the tail of the booby in attempts to make it disgorge its catch (cf. Lawry, 1926). Food regurgitated by the booby was either caught in midair by the frigatebird or was picked up from the surface of the water. None that landed on the ground was retrieved.

In 86 recorded observations of such attacks, no male frigatebird was involved. If males were equally as likely to attack boobies for food as are females, the probability of obtaining the above result is $(\frac{1}{2})^{86}$, or about one

chance in 7.74×10^{25}. I have been unable to locate any other reference to this division of labor between the sexes and I do not know its significance. Very likely, however, it is related to some other aspect of the species' breeding biology—perhaps a division of labor at the nest. An especially important question in this connection is whether the same situation prevails at times of the year other than the breeding season.

Male frigatebirds *were* seen attempting to secure nest materials from flying boobies, and on one occasion a number of boobies combined to force a flying male frigatebird to abandon some nest materials.

SOARING BEHAVIOR

On evenings when there was sufficient wind to create an updraft at the windward edge of the island, many boobies (likely those just relieved at the nest) formed a soaring group in the updraft. The birds maintained this behavior for long periods, although how long any single individual did so is unknown. If I walked beneath them, they followed above me until I left the area of the updraft. At times, individuals dropped to a lower level to observe me carefully from within 5 or 10 feet (see Farquhar, 1900). Investigative behavior of this sort was most pronounced among subadult birds, many of which were seen observing several feet of the mast of a sailboat, for several minutes at a time, by drifting up and down on outstretched wings within a foot of the structure. Similar behavior was directed toward a lighthouse located near the eastern tip of the island.

Although no clear advantage accrued to birds engaged in this evening soaring behavior, a great deal of time was devoted to it. Possibly, however, this behavior could serve as practice to maintain the fine system of coordination necessary to move rapidly through the air with a minimum of flapping, just as the finest athletes or musicians must practice to maintain the precision of their skills. The boobies' size makes it possible for them to ingest enough food at one time to maintain themselves for several hours without feeding; thus they have time available for other activities. Selection should favor the most efficient utilization of time and energy (Orians, 1961), and if soaring serves as effective practice for gliding it would be adaptive. If this is the selective basis for such behavior, however, the advantage gained from practice must outweigh any disadvantage resulting from the relatively minor energy expenditure involved in soaring. Those birds that glide most efficiently will clearly consume less energy during the many hours each day they are on the wing in search of food.

Surface skimming by the booby has an advantage other than simply permitting low-energy flight, however. Gifford (1913) noted Red-footed

Boobies catching flying fish in the air when they left the water to sail over the surface. I once observed the same behavior by an immature Brown Booby (*Sula leucogaster*) in the Yucatan Channel, between Mexico and Cuba. Such aerobatics require fine control of flight and must involve considerable feedback relative to feather position, wind pressure, and wave action. At least part of this flight system would receive practice during soaring. At Half Moon Cay, flying fish comprised most if not all of the adult diet. although what proportion of this was obtained by the aerial pursuit method cannot be judged.

SUMMARY

Red-footed Boobies rely heavily on wind to take wing, although they can do so without it, even from the ground. In flight they flap and glide alternately and usually fly alone or in small groups with little or no organization. They are capable of gliding long distances just above the wave crests even on relatively calm days.

In flight to and from the feeding grounds the birds left the island early in the morning and returned late in the evening. The mean size of flight units decreased steadily in the morning and increased steadily in the evening, irrespective of the period of greatest flight density. A significant correlation between aggregate size and increasing darkness suggests the possibility that groups navigate with greater accuracy in the dark than individual birds, making it advantageous to form larger groups in the dark.

Boobies under attack from frigatebirds attempted to outmaneuver the larger birds, but were not always successful. In the 86 such attacks noted, only female frigatebirds were involved, although males were seen attacking boobies for nest materials. The significance of this division of labor is unknown, nor is it known if the same situation prevails outside the breeding season.

The boobies devoted much time to soaring when there was no clear advantage to be gained. It is postulated that this activity serves as practice to maintain the precision of flight control necessary for capturing flying fish in flight and for gliding over the crests of waves with a minimum of flapping.

ACKNOWLEDGMENT

This study was part of an investigation carried out under the supervision of Dr. G. H. Lowery, Jr. The manuscript has also been critically reviewed by Dr. R. J. Newman. Facilities and expenses were provided by the Museum of Zoology, Louisiana State University, and quarters on Half Moon Cay were generously provided by the Government of British Honduras.

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INLAND WANDERINGS OF THE ANCIENT MURRELET

Edward A. Munyer

The Ancient Murrelet (*Synthliboramphus antiquus*) has been reported from widely scattered areas of the United States and Canada. In an attempt to understand a recent record of this Pacific alcid in Illinois, I made an intensive search of the literature but found no generally inclusive discussion of these wanderings. This paper, therefore, reviews the inland distribution of Ancient Murrelets in North America, relates the distribution to weather conditions, and presents a hypothesis concerning the direction of inland movements.

Normal range.—Ancient Murrelets live along the coasts and offshore islands of the North Pacific from Japan and the western coast of the United States northward. They breed "from the Komandorskie Islands and Kamchatka to Amurland, Sakhalin, the Kurile Islands, Korea, and Dagelet Island; and from the Aleutian, Sanak, and Kodiak islands to Graham and Langara islands in the Queen Charlotte group, British Columbia; casually to northwestern Washington (Carroll Island)" (AOU Check-list Committee, 1957). There is apparently only one record of their breeding in northwestern Washington, that reported by Hoffmann (1924).

Bent (1919) states that "the fall migration consists of a general offshore movement and a gradual southward drift, off the coast, as far south as southern California. . . . [the birds spending] the winter on the open ocean." According to the AOU Check-list (1957), they winter "from the Komandorskie Islands south to Fukien, Formosa, and the Ryukyu Islands (Ishigaki); and from the Pribilof Islands to northern Baja California (Ensenada)." Many birds remain near their northern breeding areas, the Aleutian Islands (Gabrielson and Lincoln, 1959, and references cited therein). They are frequent during the fall and winter, along the entire coastline of British Columbia, although usually found well out to sea (Brooks and Swarth, 1925) and regularly occur from November to March along the California coast (Grinnell and Miller, 1944). During recent Christmas Bird Counts sponsored by the National Audubon Society (1954–64) they were observed at Ladner, Victoria, and Vancouver, British Columbia; Orcas and Wasp islands, Seattle, and Sequim, Washington; Oakland, Orange County (coastal), Tomales Bay, Monterey Peninsula, San Francisco, Los Angeles, and Santa Barbara, California.

Inland records.—The fifth edition of the AOU Check-list (1957) lists the following inland records: "interior British Columbia (Swan Lake, Okanagan) [one record], Oregon (Bend), Nevada (Elko), Idaho (Hayden Lake),

TABLE 1
INLAND DISTRIBUTION OF *SYNTHLIBORAMPHUS ANTIQUUS*

Location	Date	Authority	Remarks
Lake Koshkonong, Jefferson Co., Wisconsin	Late Oct. 1882	Sennett, 1884	Shot on lake
Toronto, Ontario, Canada	18 Nov. 1901	Fleming, 1912	Shot 2 miles out on Lake Ontario
Lake Hook, McLeod Co., Minnesota	5 Nov. 1905	Roberts, 1932	Shot on lake
Crystal Beach, Ontario, Canada	15 Nov. 1908	Fleming, 1912	Dead on northeastern shore of Lake Erie
Montreal, Quebec, Canada	13 April 1913	Lewis, 1923	Captured
Lehi, Utah Co., Utah	21 Dec. 1925	Woodbury et al., 1949	Taken at Jordan River near Lehi
5 miles east of Tekamah, Burt Co., Nebraska	27 Oct. 1929	Swenk, 1933	Shot near Missouri River
Hayden Lake, Kootenay Co., Idaho	29 Dec. 1929	Hedges, 1941	Found dead
Swan Lake, Okanagan, British Columbia, Canada	26 Oct. 1939	Munro and Cowan, 1947	Collected
Bend, Deschutes Co., Oregon	18 Nov. 1950	Jewett, 1951	Found alive near Bend
Little Cut Foot Sioux Lake, Itasca Co., Minnesota	22 Nov. 1950	Gunderson, 1951	Caught in a bullhead net
Sandusky Bay, Erie Co., Ohio	28 March 1951	Handley, 1953	Two seen, one netted on Lake Erie
(200 airline miles NE of White horse) Pelly Lake, Yukon Territory, Canada	Nov. 1951	Soper, 1954	Caught in a fish net by an Indian
Mabton, Yakima Co., Washington	22 Nov. 1951	Svihla, 1952	Taken from an irrigation ditch
Lake Pontchartrain, Orleans Co., Louisiana	6 May 1954	Newman, 1954 and Lowery, 1960	Swam up to a skiff, north of Little Woods, La.
Roosevelt, Duchesne Co., Utah	12 Nov. 1955	Scott, 1956	Captured
Elko, Elko Co., Nevada	14 Nov. 1955	Gullion, 1956	Dead in a yard, one other seen alive in area
Almota, Whitman Co., Washington	25 March 1956	Solf and Verner, 1956	Sight record, on Snake River
9¾ miles west of Anatone, Asotin Co., Washington	27 Oct. 1956	Buss, 1957	Flew out of fog bank in mountains (elev: 5,100 ft)
Lafayette, Boulder Co., Colorado	28 Nov. 1957	Douglass and Douglass, 1958	Dead along road "just south" of Lafayette
Pelican Lake, Crow Wing Co., Minnesota	14 Nov. 1961	Lupient, 1962	Shot on lake
Cranbrook, British Columbia, Canada	7 Dec. 1961	Guiguet, pers. comm.	Captured
5 miles NE of Macomb, McDonnough Co., Illinois	16 Nov. 1962	Balding, 1964	Captured on gravel road
Spokane County, Washington	Late Oct. 1963	Rogers, 1964*a*	Picked up alive
Missoula, Missoula Co., Montana	19 March 1964	Rogers, 1964*b*	Found alive in residential area

FIG. 1. Inland distribution of the Ancient Murrelet in North America. Filled circles represent records discussed in text and listed in Table 1.

Nebraska (Tekamah), Minnesota (Lake Hook), Wisconsin (Lodi, Lake Koshkonong) [two records?], Ohio (Sandusky Bay), southern Ontario (Toronto, Crystal Beach) [two records] and southern Quebec (Montreal)." These and 12 other records are shown in Figure 1. Table 1 presents additional information for most of the records plotted.

Weather records.—Knowledge of weather conditions was obtained from (1) the United States Weather Bureau's *Climatological Data, National Summary* (various monthly and annual sections, as cited in text: 1950–64); (2) *Audubon Field Notes* (various issues, as indicated: 1946–64); and (3) literature concerned with specific inland wanderings.

DISCUSSION

Effects of weather.—Various authors discuss prevailing weather conditions in attempting to explain individual inland records. Sennett (1884) noted that a bird from Wisconsin was taken "during a northern 'blizzard'—a storm so severe that it drove most of the ducks out of the lake." Gunderson (1951) suggested that a Minnesota record was correlated with a drop in temperature of 45 degrees in less than 24 hours and strong northwest winds. Fog, snow storms (Buss, 1957), and strong southwesterly winds (Svihla, 1952; Solf and Verner, 1956) were variously related to three records from eastern Washington. Jewett (1951) pointed out that strong winds moved in from the North Pacific for 3 days prior to the finding of an Ancient Murrelet in central Oregon. Gullion (1956) discussed "the first major winter storm" and the collection of a dead bird in Nevada. As Gullion hypothesized, the high winds did apparently carry more than one bird inland: an Ancient Murrelet, associated with an "unprecedented cold wave" according to Scott (1956), was captured 2 days earlier in eastern Utah. A bird collected in Colorado may have been influenced by westerly winds which reached velocities of 170 miles per hour at high altitudes (Douglass and Douglass, 1958). Recently, in interior British Columbia, one was taken "following a heavy storm which moved from coast to interior" (C. J. Guiguet, pers. comm., 6 Oct. 1964).

During the present investigation, recent records were compared with pertinent weather analyses. Severe wind damage and/or other unusual characteristics, such as fog, made most storm systems associated with western and some central inland wanderings readily identifiable. For example, the storm system bringing birds to Nevada (Gullion, 1956) and Utah (Scott, 1956), during November 1955, also brought the lowest temperatures since 1896 to Oregon and 60 to 80 miles per hour winds to most of the Northwest (U.S. Weather Bureau. November 1955:Vol. 6).

Although inland wandering has been recorded primarily during October and November (Table 1), a time when birds are presumably moving southward, it may also start while birds are wintering or returning to the northern breeding areas. Records supporting this are Solf and Verner's (1956) sight record of a bird in western Washington on 25 March, and a record from western Montana dated 19 March (Rogers, 1964*b*). The Washington record

may well be related to a severe storm that struck a few weeks earlier. Associated with a deep low-pressure center over the Queen Charlotte Islands, British Columbia, this storm moved rapidly eastward across the state, bringing damaging winds of 60 to 90 miles per hour (U.S. Weather Bureau, March 1956:Vol. 7). The Montana record may have resulted from a similar storm recorded by the United States Weather Bureau (March 1964:Vol 15, p. 107): "By March 11, another storm was intensifying over southern British Columbia, Canada. Winds reached 45 to 55 m.p.h. along our northern Pacific coast."

Correlation of inland records with coastal storms was moderated by a lack of knowledge regarding the Ancient Murrelet's ability to adapt to freshwater and/or withstand arid terrestrial conditions. This same question may be similarly considered in relating the inland occurrences of other alcids to their seasonal activities, or specific weather patterns, or both. During November 1950, Ancient Murrelets were collected in Oregon and Minnesota (Jewett, 1951, and Gunderson, 1951, respectively); according to Handley (1953), 4 months later, during March 1951, two were seen (one was collected) on Lake Erie. Although unusual weather conditions are implicated for the November records (by Jewett, 1951, and Gunderson, 1951) and other March records (as discussed elsewhere), I could not find comparable weather patterns for the March record (weather conditions were not discussed in Handley's report). Handley's birds may have wintered on Lake Erie. A May record from Louisiana and an April record from Montreal also apparently represent birds that were not collected until months after they had wandered inland.

A recent Illinois record dated 16 November 1962 (Balding, 1964) may be related to a series of record-breaking storms that struck the Pacific coast during mid-October. According to the United States Weather Bureau (Oct. 1962:Vol. 13), the hurricane-force winds striking Oregon at that time brought "one of the major weather catastrophes of the state's history." During the latter part of October, according to the same report, "heavy fog was unusually frequent and persistent in the Pacific Northwest." Either of these, fog or high winds, might force a flock of Ancient Murrelets inland.

Adverse coastal weather conditions are clearly involved in inland wanderings of this species. Whether other factors of an intrinsic or biological nature are involved is unknown. Perhaps an occasional Ancient Murrelet is simply blown off course.

Probable routes.—In relating an Oregon record to his Nevada record, Gullion (1956) recently suggested that one would expect birds being diverted while on southerly migration to be gradually pushed inland as they moved south rather than to be blown directly east from the northern California

coast. Analyses of various reports and patterns of distribution as shown in Figure 1 indicate that this is indeed the explanation for many records from the western United States. Although the evidence is rather limited, a southeasterly drift may also characterize movements of birds recorded from the eastern half of the continent. This idea is implied in earlier speculations: Sennett (1884) theorized that a bird reached Wisconsin in 1882 by way of the Mackenzie River Valley and Canada's interior lakes, and Fleming (1912) discussed "Mr. A. C. Bent's suggestion" that birds reached the Great Lakes area after wandering through the Northwest Passage and into Hudson Bay. Both workers thought that the Rocky Mountains posed too great a barrier, that having passed through the Bering Strait, the birds represented an extended "summer migration," or lost Arctic Ocean "stragglers." Records of Ancient Murrelets north of the Bering Strait are apparently not known; but, as shown by more recent inland records, they are able to fly across (or are blown across?) mountains. Those crossing in the Yukon Territory and British Columbia during October and November, if not actively migrating in a southerly direction would conceivably be forced, because of adverse climatic conditions, to move southward. Noteworthy cold air intrusions preceded the recovery of Ancient Murrelets in Wisconsin (Sennett, 1884) and Minnesota (Gunderson, 1951).

A lack of records from Canada's interior and the prevailing pattern of winds across the United States (from west to east) may detract from the hypothesis that eastern birds traveled in a southeasterly direction. But the many lakes in central Canada could afford a safer route and the westerly winds during a period of active southerly migration would presumably force a wanderer toward the southeast. Although some records occurring during the same season form a nearly straight line extending from west to east (such as Oregon, 1950; Minnesota, 1950; and Lake Erie, 1951—see Fig 1), storm activity along the Pacific coastal regions has driven wintering or migrating Ancient Murrelets inland at different points; a record from the Yukon Territory and one from eastern Washington are dated the same month of the same year (Table 1).

SUMMARY

Published inland records of the Ancient Murrelet in North America are reviewed and their relation to weather conditions discussed. Most of the records are directly or indirectly associated with weather disturbances over the Pacific coast. About two-thirds of the records are dated November or late October, presumably months of great migratory activity. Although positive evidence is scanty, a southeasterly drift rather than a direct west-to-east movement is indicated for both western and eastern records and the birds are apparently able to survive for considerable periods on freshwaters.

ACKNOWLEDGMENTS

For information about certain records, I am grateful to the following: Dr. C. J. Guiguet, Provincial Museum at Victoria, British Columbia; Dr. Owen J. Grommc, Milwaukee Public Museum; Dr. J. Douglas Heyland and Raymond Cayouette, Quebec Wildlife Service and Zoological Gardens, respectively; Dr. Harvey L. Gunderson, University of Nebraska; and Dr. Robert J. Newman, Louisiana State University. For reviewing this manuscript, appreciation is also extended to Dr. Paul W. Parmalee, Milton D. Thompson, and Orvetta M. Robinson, Illinois State Museum. Advice and criticisms offered by Dr. Parmalee were especially valuable.

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ILLINOIS STATE MUSEUM, SPRINGFIELD, ILLINOIS, 12 NOVEMBER 1964

THE NESTING OF THE PINE SISKIN IN NEBRASKA*

Alfred E. Perry

The Pine Siskin (*Spinus pinus*) has been known for some time to nest sporadically in southeastern Nebraska. Swenk (1929) has shown that in some years there seems to be a correlation of certain temperature phenomena and nesting. This seems to occur when population levels are high and April temperatures are subnormal, or if supernormal April temperatures are followed by subnormal May temperatures. Weaver and West (1943) have also shown that where breeding occurs outside of the ordinary breeding range it is usually associated with high population levels.

In the early spring of 1961, large flocks of Pine Siskins could be seen almost every day at Pioneer Park in Lincoln, Nebraska. Later this same spring, nesting was observed in several places in the state. One nest was observed at Kearney, Nebraska, and five were found on the campus of Union College in Lincoln.

The writer and several students of Union College carried out observations in an effort to learn more about the nesting of this species outside of its normal breeding range. Measurements of nests and eggs were made and daily weights were taken of several young.

DESCRIPTION AND COMPOSITION OF NESTS

The process of nest building was not observed, as all nests were complete when discovered with the exception of Nest 5, which was abandoned after only the outer shell had been completed. All nests were found in small eastern red cedar shrubs (*Juniperus virginiana*) in close proximity to buildings. The distance varied from about 3 feet to approximately 8 feet from the wall of the building, and in one case the shrub was in a corner situation with the walls on two sides 3 to 4 feet away. The nests were found at varying heights (Table 1). The nest is the attached statant type and consists of three layers. The outer layer is composed of rough, coarse material, usually quite loosely woven and consisting mainly of large compound rootlets, heavier single stems of grass, and large pieces of string. The middle layer was found to consist of more tightly woven material: smaller, single rootlets: many quite long grass blades running nearly the circumference of the nest; and fine string, twine, thread, and cord. The inner layer contained almost all the "fuzz" and textile fibers and most of the hair present. Scattered throughout the nests were odds and ends of cedar,

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TABLE 1

MEASUREMENTS OF PINE SISKIN NESTS IN LINCOLN, NEBRASKA

Nest No.	1	2	3	4	5	Average (1–4)
Height from ground (ft)	5.5	9.5	6.1	4.2	15±	6.3
Distance from building (ft)	3.0	4.0	8.1	3.3	50±	4.6
Outside diameter (mm)	77	80	65	80	—	75.5
Outside depth (mm)	50	35	40	50	—	43.75
Cup diameter (mm)	50	50	40	50	—	47.5
Cup depth (mm)	25	25	25	23	—	24.5

leaf fragments, paper, and occasional dried insects. These seemed to have no particular area of concentration but were distributed at random. Table 2 shows the nest composition of two nests analyzed after the young were fledged. Numbers of individual pieces are given where counting was possible; otherwise weights are given. Table 1 gives measurements of four of the five nests found in this study.

DESCRIPTION OF EGGS

Egg-laying was complete in all nests at the time of discovery. Table 3 shows the number of eggs and young at this time, as well as measurements and weights.

The only two eggs in Nest 1 were of the Brown-headed Cowbird (*Molothrus ater*). No cowbird eggs were found in any of the other nests. The

TABLE 2

COMPOSITION OF TWO PINE SISKIN NESTS ANALYZED AFTER FLEDGING OF THE YOUNG

Nest No.	1	3
Grass blades and stems	277	146
Grass rootlets	458	527
String, fine cord, twine, thread	137	59
Feathers	3	2
Fecal matter (weight)	0.3 g	2.2 g
Hair	1,067	673
"Fuzz" and textile fibers (weight)	0.8 g	0.5 g
Leaves	1	0
Fireweed (*Kochia*)	34	75
Paper	1	0
Insects	1	1
Spruce	9	0
Eastern red cedar (*Juniperus*)	few scraps	few scraps
Unidentifiable material	1.0 g	1.0 g

TABLE 3
DATA FROM FIVE PINE SISKIN NESTS IN LINCOLN, NEBRASKA

Nest No.	1	2	3	4	5
Date of discovery	15 May	22 May	22 May	22 May	7 May
Number of eggs	2 (cowbird)	4	2	3	0
Number of young	0	0	2	0	0
Eggs:					
Long measurement (mm)		17.5 17.2		18.5	
Short measurement (mm)		13.1 13.5		13.0	
Weight (grams)		24 May 1.3		24 May 1.4 1.3 1.5 25 May 1.3 1.3 1.5 26 May 1.5	

siskin eggs had a background of a very light bluish white color with light brown spots more concentrated at the large end. There were also a few larger and much darker spots on the large end, with a winding string of pigment between these spots. The normal clutch size would seem to be three or four eggs.

INTERSPECIFIC RELATIONSHIPS

Cowbird parasitism of the Pine Siskin has been noted by several workers. Swenk (1929) and Dales and Bennett (1929) have mentioned this, and it has also been reviewed by Friedmann (1963). In the present study one nest of five was parasitized with two eggs. One of these eggs hatched on 19 May and the other on 20 May. These two young were cared for by the adult siskins until 26 May, when the young cowbirds were found dead in the nest and a search of the area did not reveal the whereabouts of the siskins. By this time the young cowbirds were as large as the adult siskin, and in the day preceding death they could be seen with their heads sticking up above that of the brooding female siskin.

On 31 May I observed a female cowbird examining Nest 2. She stayed at

the nest about 10 seconds and then flew away. The young siskins were then 7 days past hatching.

A Robin (*Turdus migratorius*) nest containing four young was located within 20 feet of Nest 4, but the siskins seemed to pay no attention to any activity at this nest.

On several occasions the female Pine Siskin was seen to watch intently as Blue Jays (*Cyanocitta cristata*) and Common Crows (*Corvus brachyrhynchos*) flew overhead, and each time she appeared to be somewhat nervous.

PARENTAL CARE

Incubation was apparently carried on entirely by the female, and during it she was fed by the male. Feeding was by regurgitation, the female placing her bill inside that of the male. The food material appeared to be semisolid. The female was always seen to flutter her wings rapidly and open her mouth in a begging attitude as the male approached the nest to feed her. Reid (1929) has described this behavior in North Dakota. In a 2-hour observation period during incubation, the male fed the female four times. The female left the nest four times, usually just after feeding, and for 1 or 2 minutes each time. The female was seen to raise herself up off the nest and either turn the eggs or change positions some seven times. On another occasion she was seen to change positions three times during a period of an hour.

Brooding, also, is apparently carried on entirely by the female. During the early part of the nestling stage the male continued to feed the female by regurgitation, and then she in turn fed the young. During 2 hours and 10 minutes of observation at one nest, the female was fed 4 times and was seen to feed the young 15 times. In the parasitized nest, during 7 hours and 30 minutes of observation, the female was fed 7 times and fed the young 16 times. Not all of the observation time was continuous, so little valid information on number of feedings could be obtained. There did seem to be a greater number of feedings during the morning hours than at midday or in the afternoon. Dales and Bennett (1929) found that in Iowa the young were fed at 25- to 30-minute intervals. Weaver and West (1943) found that the male continued to feed the female on the nest for 8 days after hatching of the young.

Nest sanitation was continued for a period of about 5 or 6 days, the female apparently swallowing the fecal sacs. After the sixth day the excreta of the young birds rapidly accumulated around the nest, and by the end of the nestling period there was much on the nest itself (Table 2).

The instinct to protect the young and stay at the nest was exceptionally strong with the female siskin. During the weighing of the young the female had to be forced off the nest almost every time a nestling was removed. When

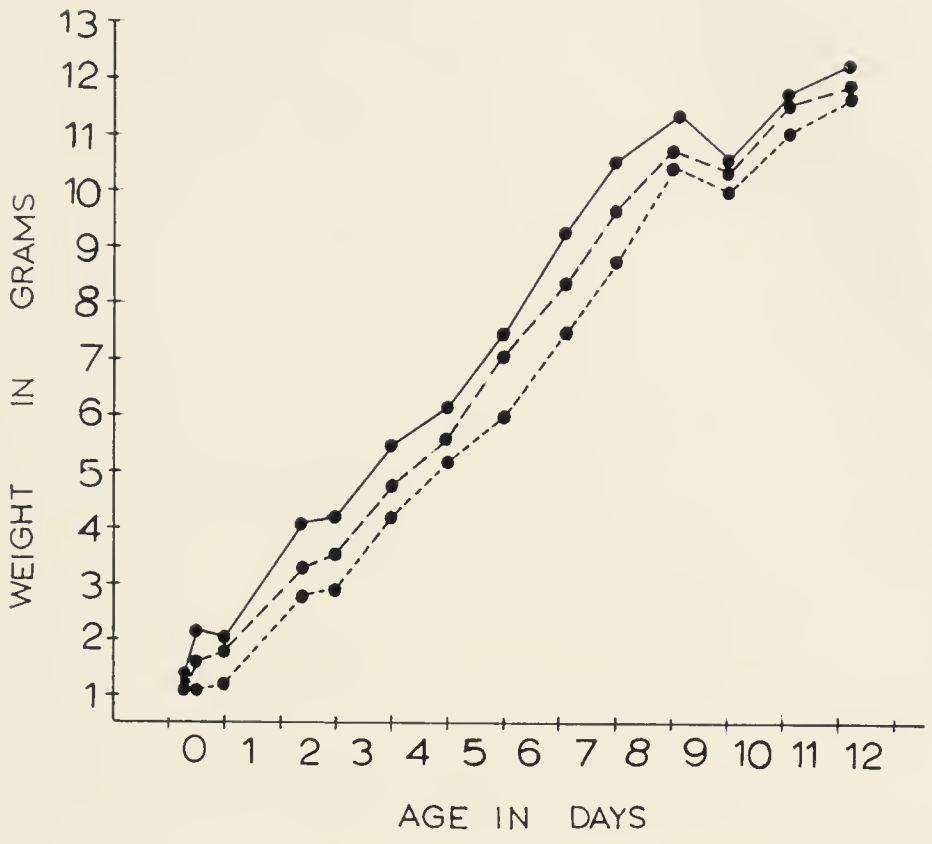

FIG. 1. Weight increase of marked young Pine Siskins in Nest 2 on Union College Campus, Lincoln, Nebraska.

forced off the nest she would fly only a short distance, and then return to the nest before the young could be replaced and another taken. This procedure did not seem to bother the female, and where it was carried out there was no nest desertion or decrease in nesting success. At the parasitized nest, also. the female had to be lifted off on several occasions in order to observe the eggs and young.

During several periods of rainy weather a female was seen to brood the young with her wings extended over the sides of the nest to keep the young dry.

Two of the nests were exposed to the direct rays of the afternoon sun, and during several days of quite warm weather the female was seen to perch on the west side of the nest with her wings outspread, shading the young from the direct rays of the hot sun. She was also seen to flap her wings slowly during this time.

GROWTH AND DEVELOPMENT OF YOUNG

Observations were made on the growth and development of young in three of the five nests found. Daily weights of the marked young in two nests were taken with a triple beam balance. Figures 1 and 2 show weight

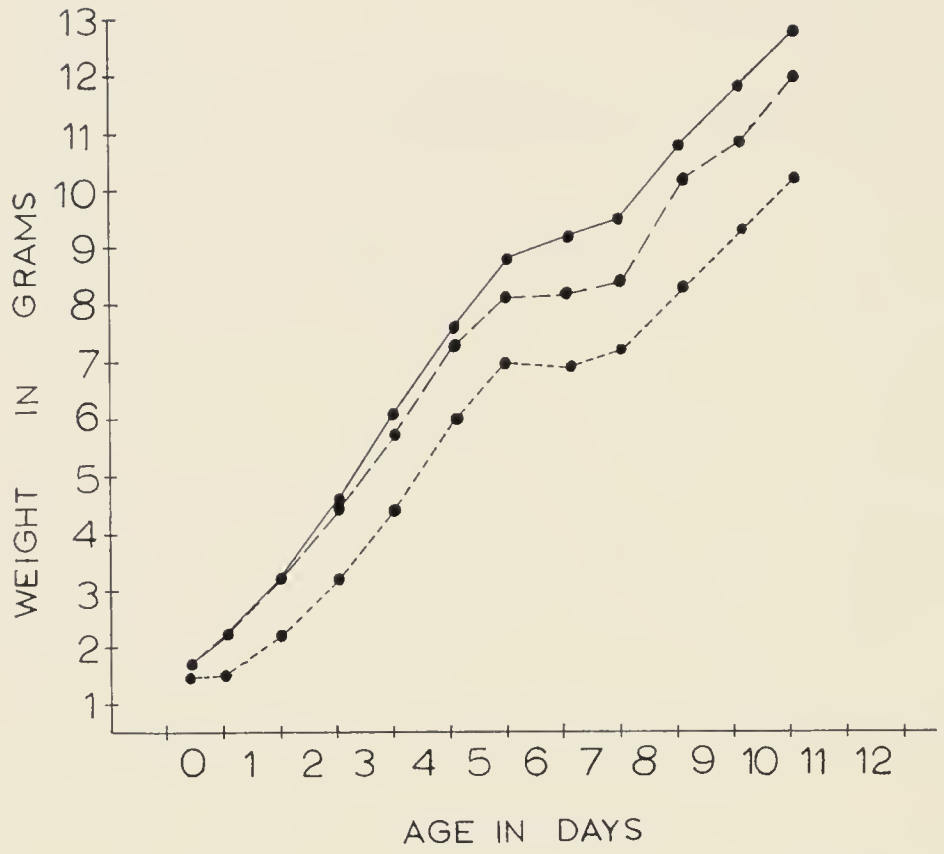

FIG. 2. Weight increase of marked young Pine Siskins in Nest 4 on Union College Campus, Lincoln, Nebraska.

increase in these young. Weaver and West (1943) have indicated that incubation begins with the laying of the first egg and lasts 13 days. In the three nests observed during the present study, the young all hatched within a maximum of 36 hours. In Nest 2 the first egg hatched between 6:00 PM and 10:30 AM the following morning. By 11:00 AM the second young hatched and by 6:00 PM the third hatched. This spanned 24 hours and seems to indicate that incubation might not have begun with laying of the first egg, as reported by Weaver and West (1943). The shell is apparently removed from the nest immediately after hatching as no shell or fragments were ever seen in the nests. The exact length of time between pipping and hatching was not determined; however, in Nest 4, where the third egg was pipped at 5:00 PM, a check at 6:00 AM the following morning revealed this egg had hatched and the young was still wet and matted.

Day zero and one.—The young at hatching were a yellowish orange color. The abdomen appeared to be quite distended and the internal organs showed through the thin body wall. Dark grey down was present on the head and back region. Weight at hatching was 1.1 g. The young had the ability to hold their head erect for a short period of time during the day of hatching, and gaping was observed the following day.

Day two.—Gaping was more prevalent and the skin coloration became somewhat darker. The egg tooth was present on some young. Eye slits became visible and the amount of down increased slightly.

Days three and four.—By the third day pinfeathers were visible. Small projections were visible on the hind margin of the wing where the primaries and secondaries develop. By the fourth day, the primary pinfeathers were about 3 mm long. The skin continued to darken. The eyes opened on the third or fourth day. The lining of the mouth was bright red.

Days five and six.—During these days the most apparent development was an increase in body weight and in the length of pinfeathers. By the end of the sixth day, the primary pinfeathers were about ½ inch long, and pinfeathers on the back about ¼ inch long. Pinfeathers also started to develop around the head region. Most nest sanitation stopped, and the young were able to grasp with their feet.

Days seven and eight.—The pinfeathers increased in length to about ¾ inch on the wings, and the body feathers started to break the sheath. The skin continued to darken and tail feathers were developing. By the end of the eighth day, the young were able to perch on a finger, and wing flapping was observed.

Days nine and ten.—Feathers were opening and folding over to cover the ventral apteria. By the end of the 10th day the young were almost fully feathered, and streaking was becoming apparent on the breast. Yellow on the wings was slightly visible. Siskin-like noises were heard; however. they were coarser and deeper than that of the adult. A little down persisted on the head. When disturbed the birds attempted to leave the nest.

Days eleven and twelve.—Disturbance caused young to leave the nest. When returned to the nest they still attempted to leave. As the adults came with food, the young in the nest could be heard from over 100 feet away. By the end of the 12th day, the streaking on the venter and the yellow on the wings was plainly visible. The young were fully feathered and leaving the nest. Nest leaving was probably earlier than normal and caused by disturbances. Weaver and West (1943) in New Hampshire found that the young left the nest on the 15th day.

Day thirteen.—This is the last day that young were seen in the nest. Several were observed on the 13th day 75 to 100 feet from the nest location, being fed by parent birds.

SUMMARY

Nesting behavior of the Pine Siskin, and development of the young in four nests was studied at Lincoln, Nebraska during the spring of 1961. Nests, consisting of three layers of readily available material (grass, rootlets, and hair), were constructed in small shrubs in close proximity to buildings. The normal clutch size appeared to be three or

four eggs. Incubation did not appear to begin with the laying of the first egg as all eggs in the nest hatched within a maximum of 36 hours. Incubation and brooding was apparently carried on entirely by the female. During incubation and the first part of the nestling stage the male fed the female on the nest and the female than fed the developing young. Feeding was by regurgitation. Nest sanitation continued for 5 or 6 days. Throughout the incubation and nestling stages the female siskin demonstrated a strong instinct to protect the eggs and young.

Weight of the young at hatching was 1.1 grams and development to fledging was complete in 13 days. Nest leaving was probably earlier than normal due to repeated disturbance and observation.

One nest studied was parasitized by the cowbird and the young cowbirds were cared for by the adult siskins for about 6 days at which time they were apparently deserted.

ACKNOWLEDGMENTS

I wish to acknowledge the assistance of Barbara Virgin in nest analysis and the help of Judy Gray and Gary Hickman in routine observation of the nest sites. Thanks are also given to Dr. F. M. Baumgartner and Dr. Bryan P. Glass for reading the manuscript.

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REPRODUCTION IN THE DICKCISSEL

C. A. Long, C. F. Long, J. Knops, and D. H. Matulionis

Gross (1921) studied reproduction in the Dickcissel (*Spiza americana*) in Illinois, but owing to the secretive habits of the female little is known about some aspects of reproduction in this species, especially outside of Illinois. Most of the information discussed here was obtained by Long, Knops, and Long in Kansas; the duration of incubation was determined by Long, Matulionis, and Long in Illinois. Our investigations were made in moist, disturbed, prairie areas. One study area, nearly one-quarter-mile square, is approximately one mile northeast of Lawrence, Kansas, in the Kaw (= Kansas) River valley. This habitat is decidedly marshlike with cultivated fields on one side. The soil is exceptionally sandy. Approximately one-third of the marshlike area was covered by shallow water, but the area of water varies greatly from season to season. The water table is only a few inches to a few feet below the surface of the ground. Vegetation consisted of dense grasses, sedges, elm saplings, clover, dock, alfalfa, bindweed, cattails, and other low plants. Other birds nesting in the area were the Robin (*Turdus migratorius*), the Brown Thrasher (*Toxostoma rufum*), and the Red-winged Blackbird (*Agelaius phoeniceus*) which was especially abundant. This study area, where most of our observations were made, is known locally as the "gravel pits." A second area known to us as the "south area" was low and marshlike. It was narrow (20–30 feet in width), and extended about one-quarter mile between a road and a plowed field. Small black locust saplings, elm saplings, dock, grasses, and other low plants were abundant in this area, which is approximately 5 miles south and 2 miles west of Lawrence. In Illinois, Dickcissels were observed one mile south of Champaign in a hayfield and in a grassy roadside habitat adjacent to the field. A few elm saplings were present.

We investigated the gravel pits almost daily from 27 May to 5 July 1963. The south area was studied regularly from 20 June to 5 July 1963. In Illinois, we made observations almost daily from 4 June to 24 June 1964.

COURTSHIP AND TERRITORIALITY

In Illinois, only males were seen as early as 4 June 1964. On 11 June we saw a few females. Whenever a female appeared, she was immediately chased by from one to three males in the area. The female would fly about, closely pursued, and would then dive into the grass followed by the males. On 13 June 1964, about 3:00 PM, Matulionis observed a female, perched passively on an alfalfa plant, being mounted several times by a male. In Kansas, breeding begins at least as early as May.

Territories at the gravel pits varied in shape from oval to circular, often changing in size and shape. In one instance where a clutch had been destroyed, the territory became incorporated into another. In a similar instance a territory was infringed on by the birds of the adjoining territory. In each of these instances the female abandoned the nest soon after her clutch was destroyed. The males lingered a day or so longer but then gave up their territories. This is interesting in view of an observation of one male holding a territory in which no nests were built, while a female which occasionally entered this territory lingered in the area until young birds in a nearby territory had left another female's nest. Shortly thereafter, the mother left her territory and the unmated female then built her nest in it and laid a clutch of eggs, which were later robbed.

When we first noticed this interesting relationship we were marking eggs of one female while being watched by two females. We observed the strange female closely and noted that it was once aggressively chased in the territory by the male, definitely not in courtship. The mateless male held a territory only 40 to 100 yards away, and held it through the time we observed nesting by both of the females. Willson and Pianka (1963) in their discussion on "sexual selection," sex ratio, and the "mating system" mention a similar relationship in wrens, and suggest that such relationships indicate that the "mating system is not necessarily the direct result of a skewed sex ratio."

Dickcissel males chased only Dickcissels; they were occasionally chased by Red-winged Blackbirds and by Brown Thrashers.

NEST BUILDING AND EGG LAYING

Nests of Dickcissels are not tied to plants as are the nests of Red-winged Blackbirds and must be placed among groups of at least three stems or branches. In this study, nests were found supported by trios of alfalfa stems, of dock stems, and of branches of elm saplings. Often the nests were near the ground in dense vegetation at heights of 100–170 mm. Nests were also found about one meter (or less) above the ground in elm saplings. When Dickcissels are seen singing along grassy roadsides adjacent to fields of unsuitable habitat, careful examination of elm and other saplings along the road is a good way of finding nests.

Fitch (1958: 298) observed a female in northeastern Kansas carrying nesting material on the morning of 9 July 1953; and a completed nest containing one egg was found the afternoon of the same day. At the gravel pits, we observed one nest partially constructed on the evening of 9 June 1963; the nest was completed but lacked eggs on 11 June. Eggs were laid in this nest on successive mornings from 12 June to 15 June. Another partly constructed nest was found at 8:00 AM on 15 June 1963, was completed 17 June, and

contained its first egg 18 June. An egg was laid daily in the early morning for 4 days. An egg, one day old, was removed by us from this clutch of four. and it was not replaced. Gross (op. cit.: p. 169) mentioned a nest completed in 4 days. and the first egg was laid in it 2 days after its completion.

Clutch size near Lawrence varied from three to five eggs (mean, 4.22) for nine nests. Four nests contained five eggs; three contained four; two contained three. Johnston (1960:59) mentioned a range of three to five (mean, 3.88; mode. 4) for nine other nests in Kansas. The mean clutch size for the 18 nests is 4.05. Gross (loc. cit.) found clutch size in Illinois to vary from three to five (mean 4.03, 29 clutches). In our study at the gravel pits, early nests usually contained five eggs, but later nests contained fewer eggs. When clutch size is being considered, sterile eggs should also be considered. Long (1963) reported that four of five clutches of the Dickcissel contained sterile eggs, and 26 per cent of the eggs examined were sterile. Gross (loc. cit.) reported sterile eggs in 6 of 11 clutches.

INCUBATION AND HATCHING

The duration of time that a female incubates a full clutch may differ from the incubation period, which according to a generally accepted, working definition, lasts from the time of laying the last egg in a clutch until that egg hatches. Gross (op. cit: p. 170) found in one nest that the incubation period lasted possibly more than 10–11 days. Fitch (loc. cit.) mentioned that a clutch of four eggs "had been completed" on 14 July 1953, and hatching occurred on 23–24 July. This incubation period was at least 11 days. We found a nest containing five incubated eggs on 3 June 1963, at the gravel pits. Two eggs were pipping on 12 June, and one hatched before 8:00 AM on 13 June. This clutch or brood was destroyed about 3 hours later, probably by a garter snake. Thus, incubation lasted at least 10 days for this clutch, and probably longer. A careful review of the literature by Nice (1953) led to the conclusion that "authenticated incubation periods of less than 11 days [are] rare."

A nest at the gravel pits found partially constructed was observed. and incubation of eggs in it seemingly began after four eggs of a clutch of four had been laid. For another clutch of four, incubation began on the penultimate day of laying; but a strong windstorm with heavy rain buffeted the nest on the evening of that day (20 June 1963). This nest was several feet above the ground in an elm sapling and was severely tossed about by the wind. During the storm the female was deep in the wind-tossed nest protecting the eggs so that we first thought the nest to be empty with eggs thrown out. The next day we broke one of the eggs; the embryo had a primitive groove. For a clutch in the south area and another in Illinois incubation also began on the penultimate day (both were clutches of four). Incubation began in the south

area on 23 June 1963, and in Illinois on 12 June 1964. At the gravel pits the nest that had been buffeted by the wind was watched until 30 June 1963, but was not again observed until 5 July. At that time Knops found young in the nest which he judged to be at least 2 days old, which would indicate that hatching had occurred by 3 July. Incubation may have lasted about 13 days, which duration appeared to be too long considering our other records and published records, but Knop's observation indicates incubation lasts longer than 10 days.

In Illinois, a nest containing two eggs was found on 11 June 1964. The female was on the nest at 5:30 PM on 12 June, and three eggs were in the nest. The clutch was completed 13 June, and incubation lasted until shortly after 11:00 AM, 23 June, at which time two eggs were obviously pipping. By 4:00 PM two eggs had hatched, and another was nearly hatched (it hatched by 5:00 PM). By 11:00 AM of 24 June all eggs had hatched. Thus incubation of an egg lasts in the Dickcissel 11 days, possibly 11½ days. The four eggs hatched in the order that they were laid, but in a period of less than a day. The egg laid last did not even show signs of pipping while the others were hatching. Probably it hatched about 12 hours later; and if it did its incubation period (from approximately 6:00 AM, 13 June, until approximately 6:00 AM, 24 June) was 11 days.

Hatching described by Gross (op. cit.: p. 19) of a clutch of four occurred in 2 days, one egg hatching the first day, two the second, and one being sterile. This observation indicates that incubation time for eggs varies one day; for if incubation begins on the last day of laying *or* on the penultimate day (and if the time of development of embryos is the same for all eggs), then all eggs would have hatched *together*, or *only one* would have hatched a day late.

PREDATION

Nests near the ground were frequently robbed, with no trace left of eggs or young, probably by numerous garter snakes in the area. Franklin's ground squirrel was common in the area, and probably one nest in a sapling was robbed by this species. The nest was partially pulled down and two eggs were broken (contents eaten, shells on the ground) on one day and the last two eggs broken likewise the following day. Of nine nests of eggs or broods in Kansas, four were found robbed.

DEVELOPMENT AND BEHAVIOR OF NESTLINGS

The eyes of young Dickcissels opened approximately 4 days before the fledglings left the nest. Fledging in the Dickcissel is described by Gross (op. cit.). According to him young birds remain in the nest 8–10 days. Young

birds remained in one of our nests for 8 days and weighed approximately 14 grams (13.8, 14.0, 14.7) each the day (7 June 1963) before the nest was abandoned. The length of the longest secondary was 26 mm on 7 June. In another nest birds remained several days longer than 5 days, for on 3 June when the nest was found they had some black papillae or feathers as well as some white down. These papillae indicate that the birds were at least 4 days old (Gross, op. cit.: p. 171). One of the four young had left the nest on 6 June; the remaining three weighed 17.9, 16.4, and 15.7 grams. On 7 June a single bird weighing 18.1 grams remained in the nest. The length of this bird's longest secondary was 30 mm. Gross (op. cit.) reported the average weight of the egg is 2.76 grams.

Young in nests opened their mouths for food a few minutes after hatching. After several days in the nest, nestlings resisted efforts to remove them by clutching the grasses of the nest strongly with their feet. No noises were heard from nestlings until 1 or 2 days before they left their nest.

SUMMARY

Reproduction in the Dickcissel in moist, disturbed prairie in northeastern Kansas was investigated, and information supplementary to the extensive studies of Gross (1921) is presented. Territories are defended by males and are effectively spaced through suitable habitat. Copulatory behavior is described. One male seemingly mated with two females, whereas a neighboring male remained unmated. Territories changed in area, and in two instances after a clutch was destroyed its territory, vacated by the parents, was partially incorporated into that of another male. The position of the nest in vegetation in northeastern Kansas is described. Elm saplings along grassy roadsides are frequently nest sites of Dickcissels. The mean size of 18 clutches in northeastern Kansas is 4.05, and the number of eggs varies from three to five. Sterile eggs are common in Dickcissels, and 26 per cent of the eggs observed were sterile in northeastern Kansas. The incubation period, determined in Illinois, is 11 days. The female ordinarily begins incubation on the penultimate day of laying, but one example is given of a Kansan female beginning incubation on the last day of laying. The eyes of nestlings open about 4 days before the nest is abandoned. Young leave the nest in 8–10 days, each weighing at that time approximately 14–18 grams. Of nine clutches and broods, four were robbed by predators in northeastern Kansas. Nestlings open their mouths for food shortly after hatching; they seemingly remain silent in the nest until a day or two before leaving it.

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NOTICE

The Division of Biological and Medical Sciences of the National Science Foundation announces that in the future there will be no closing dates for the receipt of basic research proposals in the life sciences. Proposals will be reviewed several times during the calendar year, and applicants should allow 6 months between receipt of the proposal by the Foundation and notification of the decision regarding support.

NESTING SUCCESS OF EGRETS AND HERONS IN GEORGIA

John M. Teal

In 1955 while living on Sapelo Island, Georgia, I had the opportunity to undertake a study of the nesting success of the Common Egret (*Casmerodius alba*). Snowy Egret (*Leucophoyx thula*), Louisiana Heron (*Hydranassa tricolor*), Black-crowned Night Heron (*Nycticorax nycticorax*), and White Ibis (*Eudocimus alba*), all of which nested during the summer on and around an artificial duckpond on the north end of the island.

The heronry consists of a number of small islets in the middle of a pond which had only a small amount of open water, the rest being filled with cattails and other marsh plants. The nests were built on trees growing close to the edge of the water on these islands. There was no choice of particular plant species in which to build a nest. Trees (both pines and hardwoods), shrubs, vines, and even matted tangles of herbs, vines, and brambles were used as nest sites.

The study was begun in the middle of April, as soon as the birds began to construct their nests, and was continued until September, when most of the nesting activity had ceased. The heronry was visited by canoe once a week early in the morning. Four islets were selected for study. At the start of the work every nest built on these islets was followed until it was either destroyed or the young birds left. Later in the season many nests on the largest islet were left unstudied for lack of time. White Ibis began to nest last and thus only a small percentage of their nests were followed. Each study nest was marked with paint on a nearby branch for identification. The eggs were counted and weighed and the young when they hatched were counted and weighed, and finally banded. Thanks are due to Herbert W. Kale II for assistance.

RESULTS

Common Egret.—The Common Egret began to nest around the first of April, and 43 nests were marked and followed to the successful fledging of young or destruction of the nest. A rather large number of these nests, eight of 43, were destroyed before any eggs were laid. This resulted both from the insecure nest sites often chosen by this rather large, heavy bird, and the destruction of nests by animals searching for eggs. A large number of the nests that were destroyed after laying had been completed (but before hatching) were on one islet which was invaded by raccoons. In contrast to other areas, the nests which had been destroyed on this islet were not rebuilt. There were four nests in which the completed clutch consisted of two eggs,

22 nests with three eggs, and four nests with five eggs. The food of the young Common Egrets, determined from material ejected when the young were handled, consisted mainly of small fish of species found in salt marshes and estuaries. *Fundulus* and small menhaden were identified. The young began to leave the nest and could not be studied further 2 to 3 weeks after they hatched, when they began to wander into the swampy areas. They were unable to fly for some time after they left the nest, but I have no exact data on the duration of this period.

Snowy Egret.—Although about 10 per cent of the Snowy Egrets began to nest at the beginning of April, the majority (68 per cent) did not begin until June. There were four nests with two eggs, 15 with three, nine with four, and one with five. The observed food of the young was similar to that of the Common Egret, although the fish involved were smaller. On the fourth visit after hatching, the young readily left the nest upon the approach of the observer and although they returned to the nest after the disturbance their history could not be followed from that time on.

A "blushing" reaction similar to that reported for the European Heron (Lowe, 1954) and for the Black-crowned Night Heron (Noble, Wurm, and Schmidt, 1938) was observed in this species. The lores of the birds assumed a bright red-orange color which subsequently faded to the normal yellow. Blushing was associated with nest building and display.

Louisiana Heron.—Out of 15 nests of Louisiana Heron that were studied, one had two eggs as its full clutch, 11 three eggs, and three had four eggs. The nests were begun in May and June. Three weeks after hatching, the young had begun to leave the nest. The Louisiana Heron young are particularly active and expert in climbing and left their nest at the observer's approach 1 week sooner than the young Snowys. They do not go far, however, and could easily be associated with the proper nest until the fourth visit.

Black-crowned Night Heron.—Black-crowned Night Herons began to nest at about the same time as the other herons, in May and June. It was possible to follow only eight nests, partly because the species was not very common in the heronry, and partly because on the large islet many nests were built high in the trees. All the nests contained three eggs. As young, Black-crowns are easily the most pugnacious of the herons. When the observer approached the nest, they vomited and defecated with considerably more fervor than the other species. They also defended their nest vigorously, first by squawking with their wings outstretched and their beak wide open, making thrusting motions as though to defecate or vomit, even though they were by that time empty, also by making vigorous thrusts with the bill closed and used as a stabbing weapon. A small bird, 300 to 400 grams, commonly vomited fish between 6 and 9 inches long. Besides the fish, night herons on several oc-

TABLE 1
SUCCESS OF HERON NESTING BY NESTS, SAPELO ISLAND, GEORGIA, 1958

	Common Egret	Snowy Egret	Louisiana Heron	Black-crowned Night Heron	White Ibis
Nests studied	43	30	15	8	14
Destroyed					
Before laying	8	0	0	0	0
Before full clutch	4	1	0	0	0
Before hatching	12	7	2	0	8
After hatching	2	11	6	1	1
Successful	17	11	7	7	5
Nests with eggs: per cent success	49%	37%	47%	87%	36%
Nests without loss	11	2	2	3	3
Approximate number nests in colony	85	100	40	60	1,000

casions had fed on young birds. Three young White Ibis and one Snowy Egret, weighing about 100 grams each, were vomited by four different young night herons. Night heron young will leave their nest when disturbed at about 3 weeks after hatching, but they seem less inclined to leave than the other species, probably due to their more vigorous defense of themselves.

White Ibis.—During an ordinary year, only a few White Ibis have nested on Sapelo, but in the summer of 1958 approximately 1,000 nests were counted. A note from Robert P. Allen said that the Drum Island ibis colony in Charleston Harbor, South Carolina, had only four pairs in 1958, but some 3,000 pairs in 1959. Some of these may have been the birds which nested on Sapelo in 1958. A few ibis began nesting in the middle part of June, but most nests were begun around the first of July. Of the study nests, six had two eggs and eight had three. At hatching the eyes of young ibis, unlike those of herons, were closed. Their eggs weighed about 40 grams, and the young were approximately twice this size before the eyes opened, if they were growing normally. The young are excellent climbers and, from 2 to 3 weeks after hatching, left the nest on a slight provocation as soon as they were able. It was quite common to see great masses of young ibis clustered in the tops of trees where they had climbed from the nests which were distributed from the lowest branches upward. The food of the White Ibis young was almost exclusively shrimp (*Palaemonetes*), caught in the salt marshes.

EGG AND YOUNG SURVIVAL

Table 1 shows a summary of the success of the heron nesting by nests. The Black-crowned Night Heron was the most successful, which is undoubtedly

related to its pugnacious behavior. The differences between results for the night heron and those for all but the Louisiana are significant at the $P = 0.05$ level. In the unsuccessful nest, the young had been abandoned and died of exposure and starvation. Whether the adults were killed or abandoned the young for some other reason is unknown. The Common Egret was successful in about half of the nests, and most of those that were destroyed were lost before the young were hatched. While the eggs and young are on the nests unattended by adults, there are considerable periods when a predator could easily and safely steal eggs. Since the nests of this large heron are usually placed to allow an unobstructed landing, the eggs are readily visible from the air. However, once the young hatch and begin to grow, their size alone helps to protect them against predation. The Louisiana Heron also was successful in nearly half of the nests, though here the failures were more common after hatching than before. The nests of this species are better concealed, and possibly the movement of newly hatched chicks attracts more attention than eggs resting in a nest. For the Snowy Egret and the White Ibis, only slightly more than one-third of the nests were successful. Around one-quarter of those of the nests of the Common Egret and the Black-crowned Night Heron sustained no loss at all, while only a small portion of the nests of the other species were without loss of either eggs or young.

Table 2 gives a summary of the success of the nests by eggs and young. The number of eggs that failed to hatch was quite low: 2 to 3 per cent for the egrets, but around 10 per cent for the other species. Knabe (*in* Lowe, 1954) found that 3 per cent of the eggs of the Gray Heron in East Prussia failed to hatch. A 10 per cent infertility would seem an unnecessarily high wastage of the birds' reproductive effort. It is possible that part of this failure to hatch in the late June and July nests is caused by the hot sun, and resultant death of embryos, while the adults are off the nests, rather than by infertility. One instance on a clear day in July was noted (not included in Table 2) in which the desertion of the nest for about 30 minutes around 10 AM resulted in the death of pipping White Ibis eggs, but young already hatched were unharmed. This occurred after most of the eggs included in this study had hatched. The regular visits to the nests were timed so that the eggs were exposed only for a few minutes early in the day. If undisturbed by predators at least some eggs in all study nests hatched. All of the species, except the Black-crowned Night Heron for which the sample is small, lost an appreciable proportion of their eggs as a result of predation, mostly by raccoons and crows.

Losses of the young after hatching are also listed in Table 2. The one nest of Black-crowned Night Herons in which all three young starved is listed under "unknown." In all other cases the young which starved had hatched last.

TABLE 2

SUCCESS OF HERON NESTING BY EGGS AND YOUNG, SAPELO ISLAND, GEORGIA, 1958

	Common Egret	Snowy Egret	Louisiana Heron	Black-crowned Night Heron	White Ibis
Number eggs	99	96	47	24	36
Losses					
Failure to hatch	3%	2%	8%	8%	11%
Predation	44%	33%	19%	0%	50%
Number hatched	52	62	34	22	14
Losses					
Starvation	2%	10%	9%	—	7%
Predation	11%	39%	32%	—	21%
Accident	—	3%	—	14%	—
Unknown	2%	10%	16%	9%	—
Number fledged	44	24	15	17	10
Per cent of hatched	85%	42%	44%	77%	71%
Per cent of eggs	44%	27%	32%	71%	28%

Lack (1954) believes that the clutch size for most birds represents the largest number of young that the parents can feed. The habit of beginning incubation before the final clutch size is achieved assures that young which hatch first will receive most of the food and be successfully fledged, while the later hatchlings represent a sort of reserve growth potential, and will be raised only if there is sufficient food supply. If this theory is correct, there ought to be in any one year, a higher proportion of young starving in nests with four eggs than in nests with three eggs. In the present study, there were 41 successful three-egg nests; in seven of these (17 per cent) one young bird starved. There were seven successful four-egg nests; in three of these (43 per cent) one or more young starved. This difference just misses being statistically significant, due to the small number of four-egg nests found.

Predation as a cause of loss of young is less important in the larger and fiercer birds than in the smaller. There was no loss of young by predation among the 22 Black-crowned Night Heron young, and only 11 per cent among the 50-odd Common Egrets, while the other species' losses varied from 20 to 40 per cent.

Accidental death could be established only if the bird remained next to the nest after the accident. In case of accidents reported in Table 2, the young birds (dead from starvation or strangulation and exposure), were found caught in a crotch of a tree next to their nests. It is possible that part of the unknown category is the result of the approach of the observer to the nest at the stage when the young were active. Young, subsequently unable to find their way back to the nest, would perish.

Aside from the Black-crowned Night Herons, none of the birds succeeded in raising as many as 50 per cent of their eggs to fledged birds, although the Common Egret, presumably because of its size and therefore success in defending its nest, succeeded in raising 85 per cent of the eggs that were hatched. The White Ibis was also very successful in this regard, raising slightly more than 70 per cent of the eggs that hatched, while the two small heron species raised only a little more than 40 per cent of the eggs hatched. The number of young fledged divided by the number of eggs varied from 27 to 44 per cent, with the exception of the Black-crowned Night Heron, which managed to fledge 71 per cent of the eggs that were laid. This is as high as any figures reported by Nice (1957) for altricial birds, for which she found an average fledging success, as per cent of eggs, to be 46 per cent.

In all of my data there is a bias, introduced by visiting the nests. Although the extent of this bias is not known, there are a few observations related to it. I never saw raccoons on or about the heronry pond during the daylight but saw them in the vicinity in the evening. We never disturbed the birds in the evening as all our visits to the islets were in the early morning, and predation by raccoons was probably not greatly influenced by our visits. Predation by other birds was probably not greatly affected either, since they also stayed away while we were on the islet and the herons and ibis frightened from their nests as we came up to the islets returned as soon as we were a few canoe lengths away again.

The bias resulting from frightening the young birds is greater and is difficult to assess. It is quite certain that 3 to 4 weeks after hatching the young leave their nests to some extent on their own initiative, or at least as the results of causes that had nothing to do with these observations. On several occasions young were observed several feet from their nests before they had had time to go that far as a result of our presence. These birds had been banded and were resting quietly in their nests when left the week before. Certainly, however, human disturbance caused young to leave earlier and to go farther than they would otherwise have done.

A rough calculation of the amount of food needed to support the heronry can be made and compared with the food available (see Teal, 1962, for further discussion). There were about 2,000 breeding pairs and a total of 5,000 birds present in the heronries. With a respiratory rate of 1 liter O_2/hr (Zeuthen, 1953), the birds would have required 210×10^6 kilocalorie/year. On the basis of observed nesting success the young would require about 36×10^6 kcal to live and grow. The population is assumed to be stable, i.e., a number of birds equal to the number fledged dies each year. This indicates that about 250×10^6 kcal/year are needed to support this heronry. There are 275 sq km of marsh on which these birds feed resulting in a drain of

less than 1 kcal/m^2/year. Although the birds feed on shrimps and fish, these animals in turn derive their food ultimately from the marsh (Teal, 1962).

One kcal/m^2/year is only a small fraction of the marsh production suitable for food for these birds, and we may conclude that considerably more wading-bird food is produced than they use. This remains true even if the estimate of energy required by the birds is twice too small or too large. Nevertheless that food is limiting in some ways, as indicated by the fact that up to 10 per cent of nestlings starved during this particular summer. The conclusion is not that there is insufficient food to support a greater population of birds, but that food is not sufficiently available to the adults for them to raise a larger number of young. It is suggested that wading birds feeding on salt marshes are, like many other predators, relatively inefficient food gatherers and are able to take only the more easily available individuals among their prey.

SUMMARY

A study of the nesting success of Common Egrets, Snowy Egrets, Louisiana Herons, Black-crowned Night Herons, and White Ibis was made on a marshy pond on Sapelo Island, Georgia. The nests were visited once a week, and eggs and young counted and weighed. Losses were mainly in the egg stage in the Common Egret and ibis and in the nestling stage in the Snowy Egret and Louisiana Heron. Losses of the night heron were small in both stages. Losses from starvation were more common in four-egg than three-egg clutches. A calculation of energy requirements indicates that although food is limited, as witnessed by starvation of nestlings, the birds use only a portion of the marsh production of suitable prey.

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18 JUNE 1964

AN ONTOGENY OF WING-FLASHING IN THE MOCKINGBIRD WITH REFERENCE TO OTHER BEHAVIORS

Robert H. Horwich

Wing-flashing in Mockingbirds (*Mimus polyglottos*) has been observed in one context in young birds and in two other contexts in adults. The young wing-flash in response to strange situations. Adults perform the behavior in the presence of potential predators (Hicks, 1955; Selander and Hunter, 1960) and in association with foraging (see Hailman, 1960*a*). The latter context is most documented and various attempts have been made to connect wing-flashing during foraging with the presence of insects.

My primary aim is to describe the ontogeny of wing-flashing and associated movements in hand-raised birds. I also identified certain of the stimuli which elicit wing-flashing and have tested their effect throughout the ontogeny. The evidence indicates that wing-flashing is derived from a balancing movement rather than a flight intention movement. Furthermore, wing-flashing appears as a gradation of responses as well as the stereotyped movement which is the "wing-flashing" described by other authors.

Since wing-flashing is not an isolated behavior, it was studied in relation to the ontogeny of closely associated movements. The total ontogeny will be described elsewhere (Horwich, MS.). The function of wing-flashing remains unknown. Lastly, the evolution of wing-flashing and similar patterns of behavior in passerine birds is reviewed.

METHODS

Thirty-five nestlings, three fledglings, and two adults were observed in the laboratory during the period from May 1963 to March 1964. About 20 unmarked adult and young birds were also observed in the field from December 1962 to March 1964.

Containers and cages.—In most cases the nestlings were taken with the whole nest. In the laboratory the original nest or an artificial nest composed of cellulose packing material was used. All except one individual were raised with at least one other nestling in a cage. The nestling cages were 1 foot in width and height by 2 feet in length. At the age of 11 to 20 days the young were transferred to a larger cage 34 inches in width by 36 inches in height by 48 inches in length. Each cage contained two branches placed so the bird could not rub its tail on the wire and at different heights from the floor to allow maximum exercise. These perches had some springiness, were of different widths, and were kept clean to prevent damage to the bird's feet.

Each of these cages usually contained one bird but in a few instances two were kept together until agonistic behavior increased so much that the safety of the birds was involved.

Diet.—The nestlings and hand-raised fledglings were fed roughly 50 per cent wax moth larvae (*Galleria mellonella*), and 50 per cent mealworm larvae (*Tenebrio molitor*), honey bee larvae (*Apis mellifera*), and hard-boiled eggs with supplemental vitamins and minerals. The feeding schedule involved approximately two or three feedings per hour from 7:00 AM to 7:00 PM. Almost all nestlings taken after 7 days of age developed in apparently good health.

A constant supply of food and clean water for drinking and bathing was contained in shallow dishes and placed on several layers of clean newspaper on the floor of the larger cages for the older birds. Food consisted of a mixture of equal parts of Big Red dogfood, turkey starter mash, and a dried fly mix which was moistened with cottonseed oil as suggested by Ficken and Dilger (1961). All birds are in good condition at this time.

Visual isolation.—One bird was visually isolated from other individuals at a time before wing-flashing developed. This was accomplished by covering three sides of the outside of its smaller cage with cardboard. It showed no difference in the development of wing-flashing. Thus I did not isolate any other birds.

Techniques of observation.—Laboratory observations were usually made while 3 to 4 feet from the bird. Notes were recorded by speaking softly into a Minifon Attaché pocket tape recorder. I was in sight of the birds during the whole period of observation. Laboratory observations of nestlings and fledglings were supplemented by field observations of young and old birds and by observations of the juveniles in captivity. An eight-power pair of binoculars was sometimes used in the field observations. These observations were most often summaries recorded after the behavior occurred and not continuous detailed notations as in the laboratory work. The ontogenies of hand-raised birds include life histories of birds up to 10 months after hatching. All notes involving protracted observations were taken with the Minifon recorder.

Presentation of stimuli.—Eight older laboratory birds were presented with various stimuli such as grasshoppers, crickets, and cockroaches of varied sizes, small moths and their larvae, slugs, small beetles, true bugs, and small movable toys about 2 to 3 inches long. At the time of presentation they were 3 to 10 months old. The presentation occurred by manually placing the stimulus object into the center of the cage, withdrawing the hand, closing the door, and stepping back 3 to 4 feet from the cage. The small moths, during later presentations, were presented to the bird through the cage wire about 2 inches above the perch. They were held in a tweezer or between two fingers. In

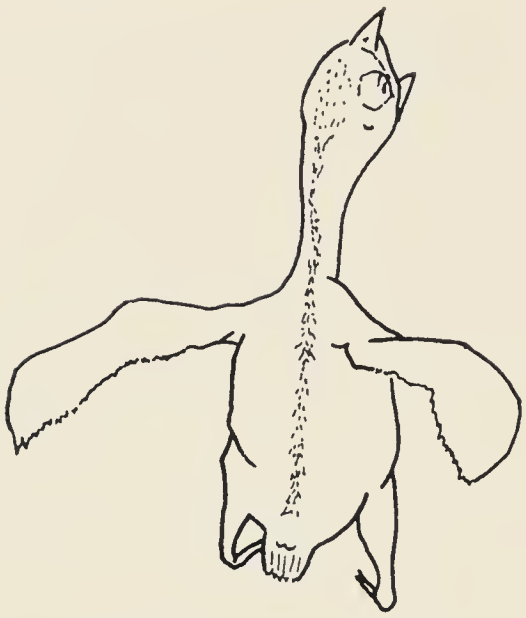

FIG. 1. The balancing movement of a 3-day-old Mockingbird nestling showing wing extension. Drawn from a 16-mm motion picture frame.

addition, observations of the birds during timed periods in a normal situation in which none of the external stimuli were presented, were noted.

Aging.—Age was estimated accurately in some cases since I knew the date of hatching. In other cases the estimation was made by correlating the feather development at the time the nestling was taken with the development in birds of known ages.

Limitations of observation.—An ontogeny of each bird was kept with special emphasis on when behaviors were first seen and when they waned. These individual life histories were then lumped and the earliest and latest appearances of behaviors were used as the limits. Although observations on ontogeny are as accurate as possible, gaps occurred when behaviors were accidentally overlooked or impossible to watch. This ontogeny is therefore open to additions by other observers.

DEVELOPMENT OF WING-FLASHING AND RELATIVE BEHAVIORS

Begging.—Nestling begging consists of a number of components, some of which are replaced by later fledgling begging movements. At one day of age the nestling has little motor control but can extend its neck, gape, and raise its body while resting on its feet and tarsi. The wings are typically extended down at its sides and outward forming an angle of 40 degrees below the horizontal. This I call a balancing movement (Fig. 1) because the wings extended in this manner may be used as balancing props on the nest sides. Motor coordination does not improve much during the second and third day.

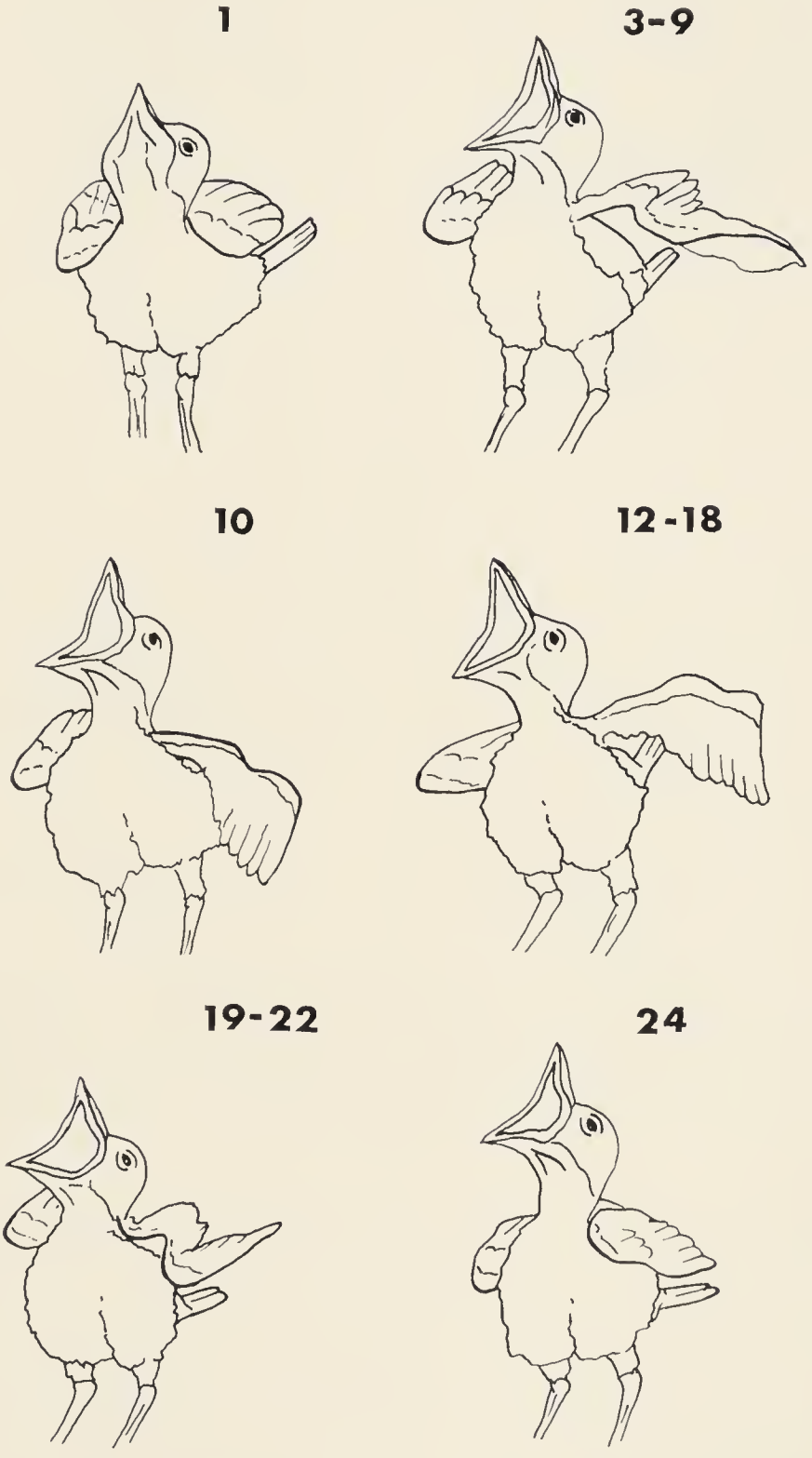

FIG. 2. A begging-balancing sequence of an 11-day-old Mockingbird. Drawn from 16-mm motion picture film taken at 18 frames per second. Frame 1, the wings are close in to the sides and the bill is up. Frames 3–9, and 10, the wings are extended, the tail is raised, and gaping occurs. Frames 12–18, the wings remain extended, the tail is raised, and gaping continues. Frames 19–22, the wings and tail are being lowered. Frame 24, the wings and tail are both lowered and gaping continues.

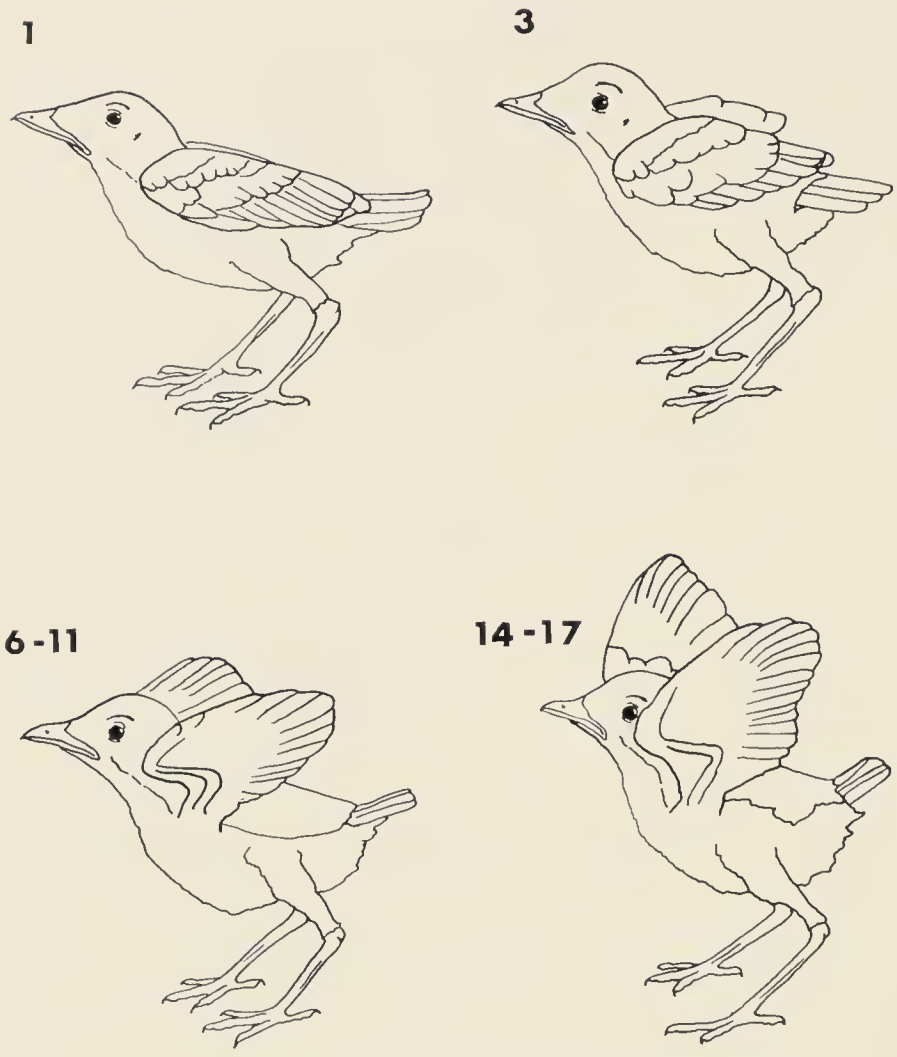

Fig. 3a. A wing-flashing sequence of a 10-day-old Mockingbird. Drawn from 16-mm motion picture film taken at 18 frames per second. Frame 1, the wings are close to the sides and the tail is parallel with the horizontal. Frame 3, the wings are being raised. Frames 6–11, the wings, having been partially raised, are now paused in the first hitch. Frames 14–17, the wings are now held at the second hitch and the tail is raised.

On the fourth day the wings become folded in closer to the sides in begging and are approximately parallel to the body whenever they are extended. The wings are quivered slightly, seemingly because of incomplete development of coordination. The first two well-coordinated wing movements occur on the seventh day or possibly a day or two earlier. They are termed "wing-flapping" and "begging-balancing." In the first, the wings are usually kept in close to the sides of the body. Then they are lifted and spread very slightly so that the leading edge of the outer primary is parallel to the body. While in this position they are raised from the horizontal up to about 30 degrees at the tip by rotation of the proximal elements which remain relatively stationary at a right angle to the body. In begging-balancing (Fig. 2) the wings are

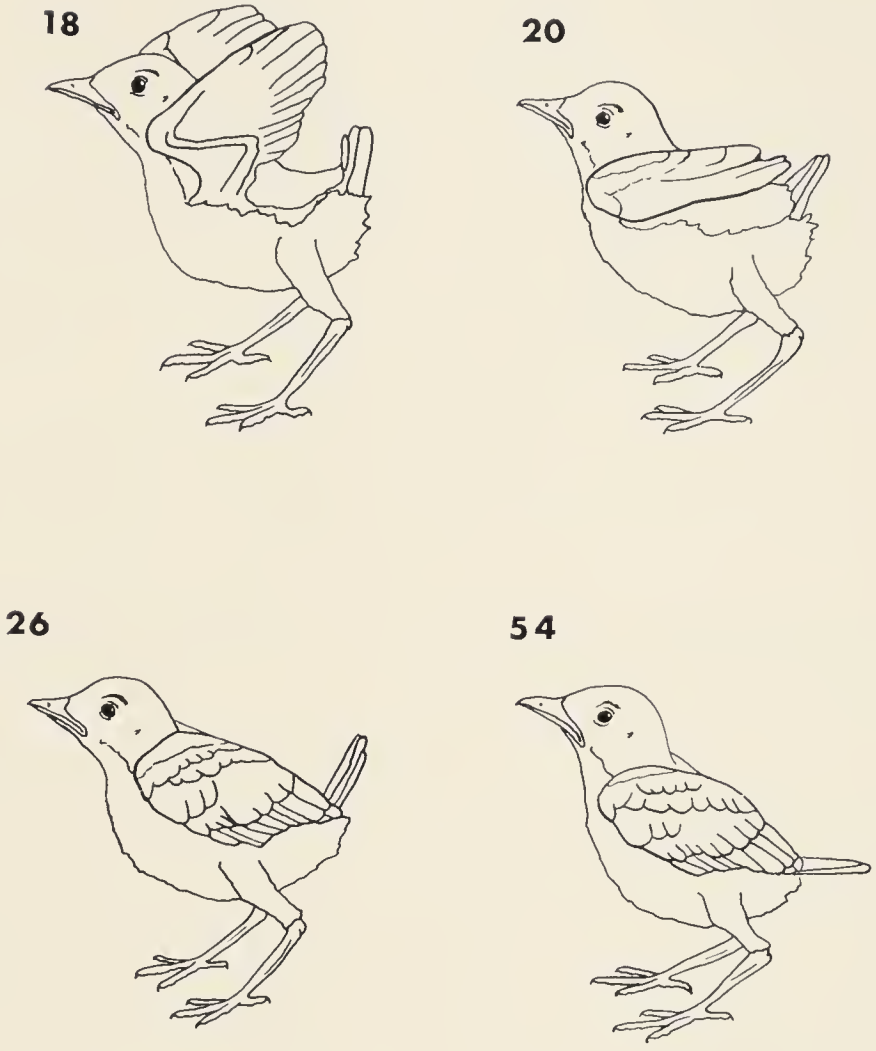

FIG. 3b. Frame 18, at the end of the last hiteh the wings are beginning to lower. Frame 20, the lowering of the wings continues but the tail is still raised. Frame 26, the wings are now completely lowered and the tail is still raised. Frame 54, the tail is lowered and the bird is in a similar position as at the start of the sequence in Frame 1.

typically horizontal and extended so that the leading edge is nearly at right angles to the body axis, although extension may be occasionally partial in one or both wings. The wings when extended are either still or shivered slightly. On the ninth day the tail is brought up while begging occurs and is brought down to the normal position after the behavior ceases.

In the laboratory the birds were often out of the nest by 8 days (rather than the natural 13 days) yet the behavior progression was not altered. Thus the ontogeny is not dependent on the birds being in the nest. It appears that begging movements do not have a regular stimulus–response connection but are rather a function of maturation.

"Fledgling-begging" appears on the 12th day. In this behavior the young

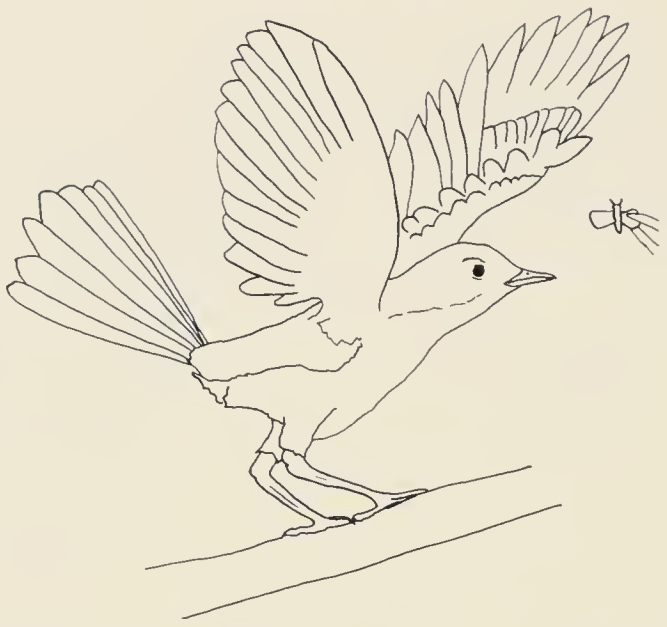

FIG. 4. A high-intensity, extended wing-flash of a subadult bird while being fed a moth. Drawn from a compilation of photographs.

birds not only show wing-flapping or begging-balancing as well as tail-raising, but they also hold the body lowered to a 45-degree angle with the horizontal and increase flexure of the legs. By the 14th day the young birds first approach and follow their human feeder. Fledgling-begging continues from then on to a maximum of the 44th day of age. The young first begin feeding themselves on the 17th day. As they become less and less dependent on hand-feeding the begging sequence becomes incomplete.

Significantly begging-balancing remains only as long as the wing-flapping. Both occurred until about the 37th day while the then incomplete fledgling-begging continued for as long as 8 days after.

Wing-flashing.—Wing-flashing appears between 9 and 13 days of age, most commonly on the 10th or 11th day.

Although wing-flashing is very varied in form, *when it first appears it is at its highest intensity* almost always when the bird is in an "excited state." Often this excitement seems to have been due to my close presence. The bird usually runs from me and tries to get through the wire at the rear of the cage. During this excited running the bird wing-flashes by extending the wings up at an 80- to 85-degree angle to the horizontal and completely extending the remiges. Thus, this movement consists of a prolonged extension *without any hesitations* until eventually the wings are quickly brought down to its sides. Often, just before or just after this movement, the bird chirps and fully extends its wings with a rapid rotation of the humerus causing rapid movements of the edge of the wing from the horizontal to 80 degrees above

and back. This is called wing-exercising. Chirping and wing-exercising are first seen on the seventh day and although they both exist in the adult, they seldom occur simultaneously. Chirping occurs when the bird is in an "excited state." Immediately after the birds exhibit the excited running and the extended wing-flash there ensues a series of stereotyped wing-flashes with hitches, which consist of raising the wings by rotation of the humerus in its socket to an angle of 80 to 85 degrees with the horizontal (Fig. 3). There is a pause each time the wings are extended at each hitch. After about two or three hitches the wings are quickly brought down into the normal position (Fig. 3). During the initial extended wing-flash I did not notice whether or not the tail was brought up. However, in all successive wing-flashes the tail is raised during the wing-flash or as the wings are being brought down after the wing-flash has occurred (Fig. 3).

In my observations of juvenile birds I have noticed a gradation of movements which are all similar to and have been designated as wing-flashes. These range from a slow partial extension of the hand and primaries parallel to the horizontal with a quick return to the normal position (resembling very closely a wing-flick in slow motion) to a full extension of both wings up and slightly forward (Fig. 4) observed when enticing the juveniles with a live insect in my hand. In this case the remiges are fully extended and the movement resembles the initial wing-flash done while running excitedly. These wing movements have occurred at an angle of 0 to 80 or 85 degrees with the horizontal. Most often these were observed when the bird's legs were not extremely bent at the intertarsal joint as in flight intention. However, in a situation similar to that in Figure 4, if the bird approached on a slanted branch it sometimes kept its legs in a position bowed at the joint with its body closer to the branch which appeared to be for a balancing purpose. Wing-flashes of one wing were observed infrequently.

Wing-flicking.—This movement is the quick extension and replacement of the hand and primary feathers out to either side of the body. This involves the rotation of the carpometacarpus on the carpels as the hand is extended. It was first noticed on the ninth day and has since been noticed when the birds were agitated or excited. Andrew (1956) suggested that this was a flight intention movement. However, I have rarely observed the wing-flicks when the birds were crouched but they occur, rather, before or after this flight intention movement.

Tail-flicking and related movements.—This motion involves the quick upward vertical movement of the tail followed by a slower resuming of its normal lower position. This was first noticed at 11 days and has continued to date. There is a close resemblance of this to the tail-raising component

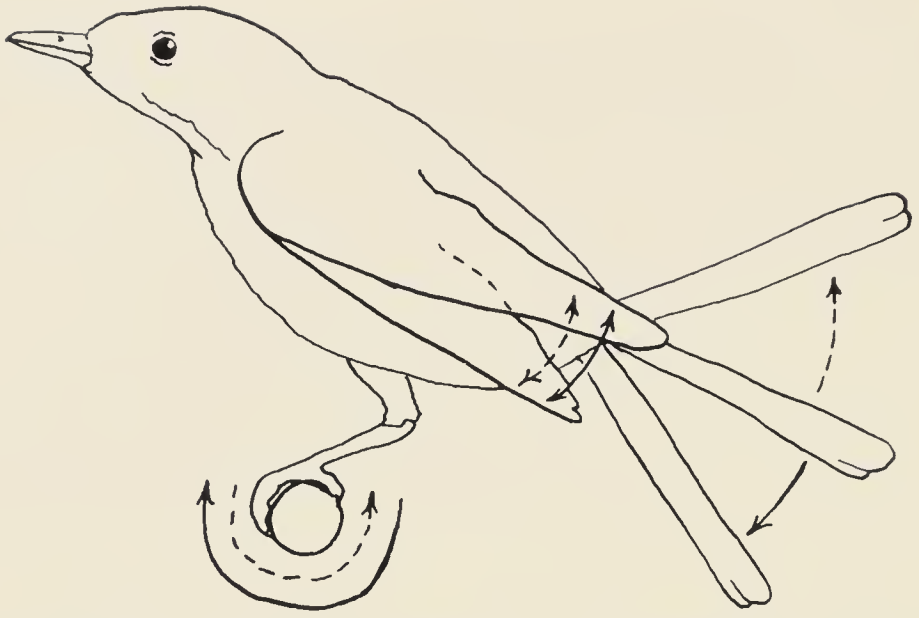

FIG. 5. A diagrammatical sketch exhibiting the compensatory balancing movements of the wings and tail in response to the twisting of the supporting perch. The solid line represents the clockwise twisting of the perch and the consequent wing and tail movements. The dotted line shows the counterclockwise twisting and the bird's compensatory movements.

found in the begging and wing-flashing behaviors (Figs. 2, 3). In addition a slow movement much like that found in wing-flashing can be elicited by causing the tail to act as a balancer when the perch is twisted one way or the other (Fig. 5). In both tail-flicking and tail-raising the tail may be moved along the horizontal (usually when the bird makes a quick movement of its head and body to the side) and it may be spread to varying degrees, exposing the outer white tail feathers (Fig. 4). The main difference between the two movements is the more rapid speed of the tail-flick.

Flight.—Flight consists of movements similar to those mentioned by Andrew (1956). The bird crouches, raises its tail, thrusts its body upwards, raises its wings, beats its wings downwards and pushes off the perch by extending its legs. Flight first occurred at 13 days which is the approximate time of fledging.

Agonistic behavior.—At 10 months of age two birds fly to the adjacent sides of their individual cages, one bird up against the other, giving *kaa* sounds, fluttering their wings against the cage wall, and often extending them in a motion similar to the high intensity wing-flashing that I have elicited from hand-feeding of "wary" juvenile birds (Fig. 4).

RESULTS OF OBSERVATIONS CONCERNING WING-FLASHING

Wing-flashing was observed in all 24 birds raised in captivity past the age of 10 days. Wing-flashing occurs in both sexes and probably the frequency

TABLE 1

AMOUNT OF WING-FLASHES IN RELATION TO AGE AND OTHER BEHAVIORS

Age (days)	Uneasy Situation	Landing	Food water	Balance	Perching	Begging	Pecking paper	Stretching	Chirping	Unknown	Total
10–15	76	9	0	6	0	6	0	3	1	5	106
15–20	49	11	0	1	4	2	0	0	1	5	73
20–25	2	1	1	1	2	0	0	0	0	0	7
25–30	2	5	0	0	0	0	0	0	0	0	7
30–35	41	0	0	0	0	0	0	0	0	0	41
35–40	2	6	0	6	4	0	0	0	0	0	18
40–45	0	0	0	0	0	0	0	0	0	0	0
45–50	0	0	5	0	0	0	0	0	0	0	5
50–55	0	0	14	0	0	0	0	0	0	0	14
55–60	0	0	0	0	0	0	3	0	0	1	4
60–65	59	0	0	0	0	0	0	0	0	0	59
65–70	0	0	0	0	0	0	2	0	0	1	3
Total	231	32	20	14	10	8	5	3	2	12	337
% total	68.6	9.5	5.9	4.2	3.0	2.4	1.5	0.9	0.6	3.6	

of occurrence does not depend on the sex. Most of the observations of wing-flashing occurred from 10 to 20 days after hatching and generally seemed to decrease with the age of the bird. There appears to be a rapid decrease of wing-flashing after 20 days. In one case 59 wing-flashes were elicited from a 60- to 70-day old bird in 2 minutes after a window shade flew up unexpectedly. When all observations of wing-flashes were grouped according to the situations in which they occurred or into categories of behavior most closely associated with the wing-flashes at the time of occurrence, it was found that approximately 69 per cent of all observations were associated with a situation in a state of change in which the birds showed escape tendencies or ambivalent behaviors. These situations included the moving of the bird cages, the placing of a strange object in view of the bird, the sudden winding of a window shade, the initial capturing of the bird, the period after handling the bird, my pursuing of the bird within the cage, and other occasions when the birds appeared to be in a very excited or agitated state for some known or unknown reason. The next highest percentage of wing-flashing occurred in correlation with landing on the ground or on a perch. The third highest correlation was with food, water, and live wax moth larvae. Neither of these last two categories were above 10 per cent of the total observations (Table 1).

At 88 to 290 days of age eight of the juvenile birds were subjected to various stimuli to detect any behavioral changes. In almost all of the presentations wing-flashes were elicited by the situation. The situation which appeared

Table 2
Number of Wing-flashes Elicited by Stimuli

	1 No external stimuli	2 Insects	3 Models	4 Man with insects
Number of wing-flashes	19	110	101	359
Number of minutes of observation	165	121.5	64.5	85.5
Wing-flashes/minute	0.1152	0.9054	1.566	4.20
% wing-flashes/minute (of total time)	1.70	13.34	23.07	61.89

to elicit the most wing-flashes per minute was the presentation of the moths by hand through the cage wires. The various model toys gave the next highest amount of wing-flashes. All stimuli situations gave more wing-flashes per minute of observation time than observations during a normal period when no external stimuli were present (Table 2).

During many observations a reduced number of wing-flashes was noted towards the end of a test. For example, in one test when a small toy dog was presented, 32 wing-flashes were seen in 5 minutes of observation. Of these, 30 occurred in the first 3 minutes while the bird seemed hesitant about approaching the model. During the last 2 minutes, the bird continually pecked at the model without hesitation and only exhibited a few wing-flashes when the model was set in motion by the pecks of the bird. When this happened the bird would jump back and wing-flash. In other cases the more presentations of a stimuli the less often the wing-flashes would occur.

All observations of wing-flashing in adult birds seen in the field were during foraging, after the bird had stopped between runs. In the three incidents in which I noticed wing-flashing in fledglings, the birds were all being pursued by me. The young appeared excited and made escape attempts.

DISCUSSION

In birds from 9 days to 10 months old, wing-flashing is definitely associated with some type of strange or uneasy situation. Selander and Hunter (1960) and Sutton (1946), who terms it an instinctive behavior which indicates wariness, suspicion, and distrust, cite evidence in favor of this view. The latter also concludes that any association with food is accidental. The report of Eifrig (1948) in which he saw wing-flashing by birds on man-made supports which upon subsequent investigation yielded no insects, also supports this position. On the other hand, Hebard (1949) argued that wing-flashing done on cement or benches might have been due to association of insects

seen on previous benches or cement walks. Hailman (1960*a*) concluded that in adults wing-flashing is a foraging motion but in young birds hunger, fear, and curiosity seem to elicit the behavior. My field observations lead me to believe that Hailman's position is correct. However, my captive birds are now 10 months old and there is no indication that the stimuli eliciting wing-flashing will change when they are classified as "adults." Allen (1947) is in disagreement with my conclusions and those of Sutton (1946) for four reasons: 1) He never noticed cause for suspicion on the part of the bird; 2) the wing-flashing seemed deliberate; 3) he noticed the behavior of the parent after the young were hatched; and 4) the necessity for increased insect-gathering activity due to the hatching of the young might have prompted a change in behavior. He mentioned a possible similarity in function of the white wing patches of the Mockingbird to the white breast of the Canyon Wren which Grinnell (1924) interpreted as having the function of lighting crevices during foraging on rocks. Another supposed function is that the behavior may serve to frighten insects (Gander, 1931).

Although there seems to be an association of wing-flashing and foraging, it cannot be assumed that wing-flashing functions in foraging or that it is a causal factor in producing insect movement. In my experiments I found large grasshoppers to be the most successful insects in eliciting the behavior. As the birds became accustomed to the grasshopper, the wing-flashing waned. Thus, the insects must be viewed as the stimuli causing the behavior and the behavior should not be thought of as functioning in foraging.

Hailman (1960*b*) mentions that wing-flashing occurs commonly in the winter in southern states but rarely in the winter in northern states. He postulates that this is due to the unavailability of insects in the north during winter. In Maryland during the spring and summer most of the foraging takes place on the ground and the Mockingbirds are easily seen. During the colder months when it becomes harder to find insects, Mockingbirds appear scarce unless one searches in bushes and shrubs. Mockingbirds have been noticed spending most of their time during the winter eating berries and fruits of such bushes as various species of firethorns (*Pyracantha*), regal privet (*Ligustrum amurensis*), and various species of hawthorns (*Crataegus*).

Beal et al. (1918) present an analysis of Mockingbird stomachs. They have failed to mention the states in which the birds were collected but they have samples from every month of the year. Their results show that most of the animal food is taken in May (85.44 per cent), and the maximum vegetable consumption occurs in December and January (86.55 per cent). The large percentage of beetles and grasshoppers shows that the Mockingbirds gather a considerable amount of food from the ground. Grasshoppers appear

to be the insect most consumed. They are eaten every month and average 14.85 per cent per year. The highest consumption occurs in July (43.33 per cent) and in February only a trace of them can be found. In this same month Hailman (1960*b*) found a number of insects in a small area on which a Mockingbird had previously wing-flashed, supporting his association of wing-flashing with the availability of prey.

The occurrence of more wing-flashing in the summer might also be attributed to the large precentage of naive juvenile birds who would have the tendency to wing-flash more often.

The study of the ontogeny has led me to the conclusion that wing-flashing has its basis in a balancing movement. I am not sure whether or not the first balancing movement at 1 to 3 days is a precursor. However, the begging-balancing movement which occurs later has very distinct similarities to wing-flashing. Figures 2 and 3 show the similarities of components. In both instances the legs are not bent much and the body is held high. The bent legs and lowered body would connote flight intention. In both, the tail-raising and subsequent lowering is involved. The tail comes up during wing-flashing and begging. In both series of photographs there is a lifting of the wings and a large extension of the hand. On occasion I have noticed balancing movements and wing-flashes done with one wing as well as with two.

At this point, another movement should be mentioned. It is possible to elicit a lifting of the wings with an extension of them, without the typical slight shivering seen in the begging-balancing movement. When perched on a stick which is moved downward, the bird will produce this movement. In addition one may sometimes elicit wing-flashes and wing-flicks by twisting the perch. This also elicits a tail-raising or lowering, depending in which direction the perch is twisted (Fig. 5). In this case there is no lowering of the body as in flight intention.

Since I have seen such a gradation of movements all of which are variations of wing-flashing and since I have seen low intensity wing-flashes which resembled wing-flicks in slow motion, I would like to suggest that both the wing-flicks and wing-flashes have a common basis in balance. Often definite balancing movements in adult birds can be seen. They consist of extending the hand and primaries out and then quickly drawing them in. The movement resembles an extended wing-flick. Daanje (1950) and Andrew (1956) believe wing-flicking to be a flight intention movement. Andrew (1956) believes both tail-flicking and wing-flicking to be ritualized intention movements which are given when a tendency to fly is accompanied by a tendency to give some incompatible response. These occur before flight and after landing. I would disagree with this because I have rarely see a wing-flick in

Mockingbirds occur when a bird was crouched. Andrew (1956) suggests that wing-flicking has lost its association with the other components of flight intention and has become emancipated from most of the other flight intention movements. Balancing would especially appear as a better explanation of the occurrence of wing-flicking upon landing when it would be of utmost importance. I have seen on many occasions a Mockingbird land with its wings extended in a wing-flash. In addition, following the assumption of Marler (1956) that the "functional acts" are more primitive than displays, balancing offers as good an explanation as flight intention because it too is functional. Since many birds have a balancing movement it is conceivable that they could have ritualized them into wing-flicks. The Mockingbird perhaps, in addition, has slowed these movements down and caused a ritualization of the wing-flash which could possibly serve as a social signal.

Hailman (1960*a*) suggested that since the wing-flashes he had seen during foraging did not resemble begging nor any other wing movements, and so must represent the acquisition of an entirely new behavior. However, I would agree with Cade (1962) who regards this as an assumption which goes against the rule of parsimony. He thinks a more likely idea would be that wing-flashing is a highly transformed or ritualized behavior derived from previously existing components which can no longer be identified with certainty.

Wing-flashing has occurred predominantly in the Mimidae. Occurrences have been reported in the Calandria Mockingbird (*Mimus saturninus*) (Halle, 1948), the Graceful Mockingbird (*Mimus gilvus*) (Haverschmidt, 1953), the Galápagos Mockingbird (*Nesomimus trifasciatus*) (Hundley, 1963), the Catbird (*Dumetella carolinensis*) (Batts, 1962), and young Brown Thrashers (*Toxostoma rufum*) (Whitaker, 1957), none of which have white wing patches. In addition, a probable homologous movement was observed in the California Thrasher (*Toxostoma redivivum*) (Sargent, 1940) and in the Curve-billed Thrasher (*Toxostoma curvirostre*) (Rand, 1941). Some of my conclusions as to the ontogeny and general conditions responsible for wing-flashing are similar to those of Rand. Other birds have been said to perform a movement called wing-flashing but the descriptions were usually too vague to judge any similarities. Vaurie (1957) mentions a similar movement in the courtship of the Western Red-legged Thrush (*Mimocichla plumbea*). Sutton (1946) speaks of a similar motion in captive Roadrunners (*Geococcyx californicus*) which caused insects to reveal themselves by moving but seems to have no other similarity to wing-flashing. Hailman (1959) reported a "wing-twitching" in the Starling (*Sturnus vulgaris*) which also functions in food getting. Monroe (1964) mentioned the exact behavior performed by the Red-backed Scrub-robin (*Erythropygia zambesiana*). This turdid species has a

considerable amount of white in the wing. The foraging behavior was exactly like that of *Mimus polyglottos*. In feeding it would run, halt, elevate the tail, and wing-flash. The wing-flash consisted of a raising of the wings at an angle of 45 degrees to 60 degrees with the horizontal, in two movements with a pause in the middle. Dilger (1956) vaguely described a wing-flashing in the genera *Catharus* and *Hylocichla* which he did not compare to Mockingbird wing-flashing. The display was described as probably having been evolved and ritualized from an intention movement such as balancing or flying.

The most striking resemblance was described by Cade (1962) and was also reported by Zimmerman (1955) in Northern Shrikes (*Lanius excubitor*). Cade's description of a wing-flashing in these shrikes indicates similarity with two movements in Mockingbirds. From his description the low-intensity wing-flashing seems similar to the begging-balancing in Mockingbird fledglings. In this movement the wings are extended from the sides and are fluttered up and down rapidly during which the wing patches flash. He notes a similarity of this to the food-begging in young shrikes. During this wing-flashing the tail is spread and closes rapidly. At a higher intensity the movement seems similar to the highest intensity of Mockingbird wing-flashing (Fig. 4). In this case in shrikes the wings are greatly extended from the body but are drooped so that the primary tips are below the body axis and are swept forward with a conspicuous extension of the hands and a maximum exposure of the wing patches. The tail is also spread. Anatomically there may be some similarity but more importantly both behaviors occur under almost identical experimental conditions. In the case of the shrikes the movement occurred when a large rat was inserted in the cage, alive at first and then later when dead. In the latter case the bird still seemed reluctant to touch the rat and seemed to be testing to see if it would move. During this time wing-flashing occurred. It waned when the shrike seemed to lose interest in the rat. This situation of ambivalent behavior was noticed in Mockingbirds. Cade concludes that there is an association of this wing movement in hunting and hostile situations. With Mockingbirds if a large grasshopper is inserted in the cage the bird will approach it and the closer it gets to this new stimulus the more it appears to wing-flash. After pecking at the insect, the wing-flashing subsides. Wing-flashing appears to be due to a conflict of two motivational factors, slight fear or uneasiness and the incentive of food. This unsteady state may have led to the ritualization of the balancing movement so often employed during this conflict.

In discussing the evolution of wing-flashing it must be noted that five of the six species of Mimidae that do wing-flash do not have prominent wing patches. Thus if we regard the abundance of one character throughout

the family as being an indication of its being more primitive, wing-flashing can be considered more primitive than white wing patches. Mimids have most probably originated in South or Central America as seen by the abundance of its members there. *Mimus polyglottos* probably originated south of its present range and is even now extending itself north. This would also point to the wing patches as an innovation. Therefore, in attributing a function to wing-flashing perhaps the place to look would be in those species without the wing coloration. The patches, if they have a function as a social signal such as in species identification or population density regulation, would signal during flight landing as well because in this motion Mockingbirds often behave similarly to shorebirds by spreading the wings way out to break the flight. The wing patches then become prominent. I did not notice this behavior in three observations of landings in Graceful Mockingbirds in Panama.

In conclusion, the majority of theories on the subject of wing-flashing hypothesize its derivation from some connection with food. Food-getting is a functional act and most important to the survival of the species. However, balance as well as food-getting and flight is a functional act and must not be overlooked in a hypothesis of the evolution of wing-flashing.

SUMMARY

The ontogeny of wing-flashing in 38 hand-raised young Mockingbirds was observed. All components of the wing-flash were investigated. Wing-flashing developed in both sexes in 9 to 13 days with the average on day 10 or 11. It also occurred in one bird visually isolated from all other birds. In addition the study revealed that the ontogenetical progression of behavior was not dependent upon the stimulus of being in the nest. Although the captive nestlings were out of the nest earlier than normal, they did not attain their fledgling behavior until the usual chronological age.

The form of wing-flashing varies to a great degree, and a whole gradation of responses was noticed, from an intense, fully extended wing motion without hitches to a slow, partial extension similar to wing-flicking. Wing-flashing first occurs at its highest intensity without previous practice or imitative learning. However, a begging-balancing motion is believed to be the precursor of wing-flashing due to many similarities between the two movements.

Wing-flashing was associated with an "uneasy situation" in birds up to 10 months old. This situation in which the birds are "wary" but not completely frightened is caused by: a) strange objects; b) unexpected movements, noises, or other stimuli; c) in semi-tame birds, coming too close to man and in young birds, being handled by man. Thus wing-flashing is related to food only as it pertains to such a situation involving large, live, moving insects. The amount of wing-flashing was also influenced by age, individualities of the birds, and tameness.

ACKNOWLEDGMENTS

I am grateful to Dr. Robert W. Ficken for his suggestions on the problem as well as his corrections and criticisms of the manuscript. Dr. Millicent S. Ficken kindly offered

some suggestions on the original draft. In addition I would like to thank Dr. Jeff Swinebroad and Dr. Jack P. Hailman for any ideas derived from personal communications, and Dr. Howard H. Winn for his criticisms of the manuscript. I wish also to thank the Frank M. Chapman Memorial Fund of the American Museum of Natural History without which this particular study could not have been made.

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METABOLISM AND SURVIVAL TIME OF THE RED-WINGED BLACKBIRD*

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This study was undertaken to determine quantitatively the relationship between metabolic rate of the Red-winged Blackbird (*Agelaius phoeniceus*) and its survival time during periods when an external source of energy is unavailable. The relationship between the metabolic rate and the reserve energy supply determines the survival time of birds in different ecological or physiological conditions.

PROCEDURE

The birds used in this study were captured by the use of mist nests during the last 2 weeks of June in the State College, Pennsylvania area. The birds were maintained in the laboratory in large indoor cages (6 feet × 6 feet × 3 feet) at a photoperiod of 15 hours and at an environmental temperature of between 24 and 30 C. All birds were maintained in the laboratory for at least 2 weeks prior to being tested in the respiration chamber.

The respiration chamber used to determine the metabolic rates was an open-circuit system used by Haldane (1892). Tests by Kendeigh (1939) using measured amounts of CO_2 and moisture, showed that the gaseous output of a bird could be measured in this type of apparatus with an error of less than one per cent. Tests on the apparatus used in these experiments using measured amounts of CO_2 and moisture gave an accuracy within 0.7 per cent, which compares closely with Kendeigh's results. The basic design of the apparatus was the same as Kendeigh (1939) except four tubes instead of two were used to remove the CO_2 and water vapor from the incoming air. The respiration chamber for measuring metabolism of resting birds was constructed from a one-gallon, wide-mouth jar with a metal top and rubber gasket. The chamber for measuring roosting metabolism was a black, one-gallon, wide-mouth jar. For measuring the metabolic rate of active birds, the respiration chamber was constructed from a 12-gallon rectangular aquarium covered with heavy plastic sealed with one-inch adhesive tape. The birds were observed periodically during the tests and were found to be in an active condition. Air flow through all systems was maintained with a small air pump (75 cu. inch capacity) connected in reverse to pull air through the system. Air flow through all the systems was not measured exactly, however preliminary tests on the apparatus indicated that the air flow approximated 530 cc/min.

* Authorized for publication on 3 May 1963, as paper No. 2773 in the journal series of the Pennsylvania Agricultural Experiment Station.

Three hours before being placed in the respiration chamber, the bird was removed from a large indoor cage and placed in a small holding cage with water but no food. A study by Stevenson (1933) showed that 57 small passerine birds of different species quickly entered a postabsorptive state after being fasted. Feces from ingested grain that had been stained for identification was eliminated within 2.5 hours. Previous investigators have found that small passerine bird enter a postabsorptive state after a fast of about 2 hours (Kendeigh, 1944; Salt, 1952; Dawson, 1954; and Wallgren, 1954). Thus, the 3-hour fasting period was deemed sufficiently long enough to insure a condition of fat metabolism. Immediately before the start of each test, the bird was removed from the holding cage, weighed to the nearest milligram, and placed in the respiration chamber. The air pump was then connected and the system allowed to come to equilibrium for 15 minutes, after which the previously weighed (150 mm high $\times$ 18 mm diameter) drying tubes (weighed to $\pm$ one milligram) were connected into the system.

Each bird was tested for 3 hours; after this time it was removed from the respiration chamber and immediately weighed to $\pm$ one milligram. If feces were voided during the test these were also weighed in order to calculate the actual weight loss of the bird. The glass drying tubes were then weighed to find the grams of CO_2 (absorbed by soda lime) and water vapor produced (absorbed by $CaCl_2$). Oxygen consumption was calculated from the difference between the sum of CO_2 and water vapor produced and the loss of weight of the bird. The respiratory quotient was then calculated from the grams of CO_2 produced and the grams of O_2 consumed as described by Brody (1945:334). The temperature ranged between 24 and 30 C in both the fasting and metabolic chambers. The soda lime and $CaCl_2$ were changed after each test to assure the maximum possible absorption of CO_2 and water vapor.

The metabolism while roosting may be the basal metabolism for the Red-winged Blackbird. However, the bird may not be at complete rest during the fasting period and in the chamber. For this reason, "roosting metabolism" is used throughout this paper in place of "basal metabolism." A roosting condition refers to a bird sitting quietly in a dark chamber. Resting metabolism refers to the metabolic rate of a bird at rest the majority of the time in a lighted chamber, but the bird may be active for short intervals.

To determine survival time four birds were fasted until death in the chamber for measuring roosting metabolism and also in the chamber for measuring active metabolism. The following data were recorded: initial weight, weight at death, and the survival time. The birds were checked every 4 hours until midnight and then again at 8:00 AM.

TABLE 1

OXYGEN CONSUMPTION AND BODY WEIGHT OF RED-WINGED BLACKBIRDS IN ROOSTING, RESTING, AND ACTIVE CONDITIONS

Metabolic condition	No. of determinations	Mean cc O_2/g/hr	SE*	Mean weight	Weight range
Roosting	12	2.90	0.896	53.143	38.603–65.252
Resting	11	6.31	1.83	54.171	39.260–63.680
Active	10	12.46	2.08	53.657	38.181–62.197

* Standard error.

The total body fat of 14 birds was determined by the following procedure. The birds were minced and then dried to a moisture-free basis. The moisture-free birds were then extracted in petroleum ether for 24 hours. The total body fat was calculated as the difference in weight between the moisture-free birds before and after ether extraction. The total body fat was then expressed as a percentage of the live weight.

RESULTS

A total of 11 birds (9 males and 2 females) was used for the measurement of resting metabolism (Table 1). The mean rate of oxygen consumption for a resting bird was 6.31 ± 1.83 cc O_2/g–hr. The metabolism for 12 roosting birds (10 males and 2 females) was 2.90 ± 0.896 cc O_2/g–hr and was significantly lower than the rate for resting birds ($P < 0.01$). The mean rate of oxygen consumption for 10 active birds (9 males and 1 female) was 12.46 ± 2.08 cc O_2/g–hr and was significantly higher than the rate for resting birds ($P < 0.001$) and for roosting birds ($P < 0.001$).

SURVIVAL TIME

The length of time an animal can survive under conditions of total fasting can be predicted if the body weight and the metabolic rate of the animal are known. The energy available to the bird is equal to $0.7W$, where $W =$ weight in grams and 0.7 is derived from the proportion of the initial weight of the bird remaining at death. The energy available is derived from the following equation:

$$\frac{1 \text{ g fat}}{9 \text{ kcal}} = \frac{0.08W}{X} \qquad [X = 0.7W].$$

In this equation $W =$ weight in grams, $X =$ kcal and 0.08 is equal to the proportion of the live weight of the bird which is fat. The fat content of

TABLE 2

CALCULATED AND OBSERVED SURVIVAL TIME OF BIRDS UNDER ROOSTING CONDITIONS

Initial weight (g)	Weight at death (g)	Percentage of initial weight at death	Observed survival time (days)	Calculated survival time (days)
57	37	64.9	5.0	2.89
57	38	66.7	4.0	2.86
58	40	69.0	4.0	2.94
56	45	80.4	3.0	2.84
Mean		70.3	4.0	2.88
			chi-square = 3.50	

14 birds, determined by ether extraction of total body fat, varied from 9.3 to 7.8 per cent, with a mean of 7.9 ± 0.94 per cent of the live weight. The metabolic rate (M) was calculated from the grams of CO_2 produced per 24 hours at any given RQ (Brody, 1945:334). For calculation of the metabolic rate in kcal/bird–day, a thermal equivalent of 3.325 kcal per gram of CO_2 at an RQ of 0.722 was used (Brody, 1945:310). The survival time under any given condition can be calculated from the formula $S = F/M$, where S is the survival time (days), F is the kcal of energy available to the bird ($0.7W$), and M the metabolic rate under any given condition.

The roosting Red-winged Blackbird had a mean metabolic rate of 13.8 $\pm$ 0.042 kcal/bird–day, and the mean metabolic rate for an active bird was 40.9 ± 0.98 kcal/bird–day (measured for 3 hours). The mean calculated survival time for four birds under roosting conditions was 2.88 days, and was not significantly different from the mean observed survival time of 4.0 days ($P > 0.80$) (Table 2). The mean calculated survival time in an active condition was 0.86 days and was significantly lower than the observed survival time of 2.81 days ($P < 0.01$) (Table 3).

The metabolic rate can also be calculated from the formula $S = F/M$ if the survival time and available reserve energy are known. The mean calculated metabolic rate for birds fasting until death in a roosting condition was 10.2 kcal/bird–day and was not significantly different from the observed metabolic rate for roosting birds of 13.8 kcal/bird–day ($P > 0.75$). The metabolic rate was also calculated by theoretical equation of $M = 70W^{3/4}$ stated by Kleiber (1947, 1961). The theoretical metabolic rate, calculated by the preceding equation, of 11.8 kcal/bird–day was not significantly different from the observed metabolic rate of 13.8 kcal/bird–day ($P > 0.80$).

The weight of fat required for a bird to survive for 4 days in a roosting

TABLE 3

CALCULATED AND OBSERVED SURVIVAL TIME OF BIRDS UNDER ACTIVE CONDITIONS

Initial weight (g)	Weight at death (g)	Percentage of initial weight at death	Observed survival time (days)	Calculated survival time (days)
59	40	66.7	3.75	1.01
49	38	77.6	2.50	0.84
55	43	78.2	2.50	0.94
37*	26	70.3	2.50	0.64
Mean		73.5	2.81	0.86
			chi-square = 18.71	

* Female.

condition was 6.3 g (calculated from $S = F/M$) and was not significantly different from the 4.5 g calculated by the $0.7W$ method ($P > 0.50$). These results indicate that the survival time of birds in a roosting state may be calculated if the body weight and the metabolic rate of the bird are known. The mean metabolic rate, calculated from $S = F/M$, of birds in the chamber for measuring active metabolism was 14.7 kcal/bird–day and was significantly lower than the observed metabolic rate of 40.9 kcal/bird–day ($P < 0.001$). These data indicate that the birds probably did not remain in an active condition until death.

DISCUSSION

The mean metabolic rate of 2.90 cc O_2/g–hr for roosting birds compares closely with previous work. Dawson (1954) recorded an average oxygen consumption of 2.80 cc/g–hr for the Abert Towhee (*Pipilo aberti*) and of 2.85 cc/g–hr for the Brown Towhee (*Pipilo fuscus*). The oxygen consumption reported for the Cardinal (*Richmondena cardinalis*) was 2.60 cc O_2/g–hr at a temperature range of 24–33 or 34 C (Dawson, 1958). A metabolic rate of 2.5 cc O_2/g–hr for the Evening Grosbeak (*Hesperiphona vespertina*) at a temperature range of 20–31 C was reported by Dawson and Tordoff (1959). A metabolic rate of 3.1 cc O_2/g–hr for the Red Crossbill (*Loxia curvirostra sitkensis*) and 2.8 cc O_2/g–hr for the White-winged Crossbill (*Loxia leucoptera*) was reported by Dawson and Tordoff (1964).

The range in cc O_2/g–hr of roosting birds was not so great as that of resting birds, probably because the birds settled down almost at once after being placed in the black chamber (Table 1). Inactivity in the respiration chamber probably accounted for the small range of values. Results from the clear chamber were more erratic than those from the black chamber, probably because some birds struggled, while others sat in the chamber with little or no

movement at all. These results indicate that the metabolic rate of roosting birds is a better measure of basal metabolism than is the metabolic rate of resting birds.

Previous studies have shown that the metabolic rate of active animals is higher than the basal level. Pearson (1947) found that two species of bats, *Eptesicus fuscus* and *Myotis lucifugus*, had active rates of 17 or 18 times their basal level. Pearson (1950, 1954) found that the average active rate for a flying Anna's Hummingbird at 24 C was 68 cc O_2/g–hr; only a 5.5 increase over the basal rate for this species. Pearson also stated that the hovering hummingbird consumes oxygen at a much faster rate than that recorded for any other vertebrates. Lasiewski (1962) stated that the average metabolic rate of a flying hummingbird is 42 cc O_2/g–hr and this value is probably more representative of the flight metabolism of hummingbirds than the previously reported values. The mean increase of resting above the roosting rate was 2.24 cc O_2/g–hr and the mean increase of active above roosting was 4.30 cc O_2/g–hr. The increase in the metabolic rate during periods of activity influences the rate of utilization of reserve energy supply (fat). The relationship between the metabolic rate and reserve energy supply determines the survival time of the organism under any given ecological or physiological condition.

In 12 tests in the black chamber, the mean respiratory quotient was 0.722, which indicates that the metabolism of these birds in the roosting state was probably at the expense of fat reserves. This figure of 0.722 agrees with the 0.73 found for the House Wren by Kendeigh (1939) and Riddle et. al. (1932) for pigeons older than 22 days. The fact that a metabolic rate of 13.8 kcal/bird–day was not significantly different from the calculated basal rate of 11.8 kcal/bird–day based on Kleiber's weight-relative formula ($M = 70W^{3/4}$) lends support for the suggestion that the metabolic rate of a roosting bird may be the basal rate for the Red-winged Blackbird. A respiratory quotient of 0.722 indicates that fats make up 95.6% of the oxidized material burned by the body (Brody, 1945:310). As suggested above, this respiratory quotient indicates that the metabolic rate of a roosting bird may be the basal metabolic rate for the Red-winged Blackbird.

Odum and Perkinson (1951) determined the total body lipids of 86 individual White-throated Sparrows (*Zonotrichia albicollis*) collected at four different seasons, viz., postmigration (October–November), midwinter (January–February), molting period (March–April), and premigration (April–May). The average total body lipids in percentage of body weight were: postmigration, 6.88 per cent; midwinter, 12.05 per cent; molt, 6.25 per cent; and premigration, 16.66 per cent. The mean total body fat was

8.39 per cent of the total body weight during the postmigration, midwinter, and molt periods. This figure compares with mean lipid content of 7.9 per cent of the body weight determined for 14 Red-winged Blackbirds. Further investigation is required to determine if the method described in this study for determining the reserve energy supply of birds during the period of rapid deposition of fat prior to vernal migration is useful. However, since the lipid content of birds is variable throughout the year, the $0.7W$ method may be sufficient to estimate the reserve energy supply and total body fat of birds in the different seasons.

The reserve energy available to animals is dependent on the body weight (Morrison, 1960). The basal metabolic rate of animals is also dependent on the body weight and increases with approximately the 0.73 power of the body weight (Brody, 1945). The weight relationship to the basal metabolic rate and available energy is also the formula for metabolic body size, $W^{3/4}$, as described by Kleiber (1932, 1947, 1961). The energy available to a 50-gram bird if $0.7W$ is used for determination in 35 kcal, and the energy available is 37.5 if $0.75W$ is used for the calculation of available energy. The difference of 2.5 kcal probably is not significant in the prediction of the survival time of an animal. The survival time of an individual bird is determined by the reserve energy supply and metabolic rate. The survival time of birds is further influenced by changes in the environmental and/or internal physiological mechanisms. The interaction between metabolic rate and utilization or deposition of reserve may be a factor in regulating the various phases in the life history of the species.

SUMMARY

The oxygen consumption of the Red-winged Blackbird was determined for roosting, resting, and active birds. The mean metabolic rate for a roosting Red-winged Blackbird was 2.90 ± 0.896 cc O_2/g–hr; the mean rate for a resting bird was 6.31 ± 1.83 cc O_2/g–hr; and the mean rate for an active bird was 12.46 ± 2.08 cc O_2/g–hr. The metabolic rate for roosting birds was significantly lower than the metabolic rates for resting and active birds. The respiratory quotient for roosting birds after fasting for 6 hours was 0.722, which indicates fat metabolism.

The reserve energy available to a bird is dependent on the body weight and is calculated by multiplying 0.7 by the body weight. The survival time can be calculated from the body weight and the metabolic rate of a bird under any given condition. The calculated survival time of birds in a roosting state was not statistically different from the observed.

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FACTORS AFFECTING NESTING SUCCESS OF RING-NECKED PHEASANTS

Larry C. Holcomb

Through the spring and early summer of 1964, 11 Ring-necked Pheasant (*Phasianus colchicus*) nests were discovered in Toledo, Lucas County, Ohio. The determinate factors affecting nesting success, including interesting behavioral patterns in response to different stimuli, are reported. The earliest nest was located on 3 May and the latest on 15 June. The habitat varied considerably; nests were found in old weed fields, alfalfa, hawthorn thickets, blackberry patches, and forest. Once a nest was discovered, a tag was left near it to aid in finding it again. The location was checked each day to determine the date of hatching and the success in nesting. The nest site was approached carefully so as to not disturb the hen, and she was not flushed after the full clutch was laid. Of 11 nests discovered, three (27%) had some chicks leaving the nest. Seven chicks left one nest of 12 eggs; 15 chicks successfully left a nest of 24 eggs. A third nest had 12 eggs, all of which hatched, the young leaving successfully. Of a total number of 164 eggs laid only 34 chicks (21%) left the nest.

Reasons for nest failure could be separated into three categories: (1) behavioral conflicts, (2) rainstorms, and (3) predation. Behavioral conflicts resulted in three nest desertions, and part of the eggs from two other nests failed to hatch because the hen left the nest too soon. Rainstorms resulted in the flooding of one nest causing desertion, and in another case caused the death of 12 chicks before they left their nest. Predators destroyed three nests of eggs and removed three eggs from another.

Possible predators in the nesting area may have been opossums, raccoons, dogs, cats, Common Crows, and Norway rats. When only a few eggs were taken from a nest the predation was probably due to rats. However, on one occasion seven eggs were taken from a nest of 17. The hen continued to incubate and on the following day, the entire nest had been destroyed.

Behavioral conflicts causing nest desertions were due to: (1) more than one hen laying eggs in a nest, (2) a quail laying eggs in the nest, and (3) the presence of a cat in the nesting area.

In the late afternoon of 3 May a hen was flushed from a nest in a wooded area. The nest then contained 16 eggs. On 4 May the nest had 18 eggs, 5 May 22 eggs, and 6 May 23 eggs. When four additional eggs were found on 5 May the nest was visited the following morning and these notes taken:

0720: As the nest was approached a cock pheasant drove another cock away from the nest site and then retreated himself.

0740: A hen approached from the east and walked straight to the nest. She settled on the eggs and moved them about with her bill (the eggs were piled on top of one another). She left the nest heading west without laying an egg.

0755: A hen was observed 40 feet east of the nest. Several cocks continued crowing nearby.

0855: A cock continued crowing near the nest, returning a call in response to other cocks crowing.

0900: A female approached to within 50–60 feet northeast of the nest. She was startled by a train whistle and ran away. The observer then departed.

1500: One egg had been laid in the nest making a total of 23 eggs.

The nest containing 23 eggs was visited on every day from 7 May to 14 May. The nest site was not disturbed and no hen was ever flushed from the nesting vicinity. Possible reasons for desertion of the nest may be that (1) there was conflict between the different hens laying in the nest, (2) none of the hens would accept this large number of eggs, or (3) there may have been some influence upon the hens by the cock or cocks in the nesting area. Two eggs were laid in each of two different nests, on single days. It is possible that these hens laid two eggs in one day; however, it seems just as reasonable to assume that two different hens may have utilized the same nest on one day.

The nest deserted due to Bobwhite (*Colinus virginianus*) eggs had 13 pheasant eggs on 12 May, 14 on 13 May, and 15 pheasant eggs plus one quail egg on 14 May. The pheasant apparently deserted this nest, for she discontinued laying and did not incubate. On 20 May, a second quail egg had been deposited in the nest. The eggs remained in the nest on 19 June.

One hen pheasant deserted due to the presence of a house cat stalking near the nest site. The cat was observed watching the pheasant; however, the pheasant had seen the cat and was not sitting on the nest. The hen moved slowly away from her nest, keeping a safe distance from the cat, and she did not return. Possibly the cat captured the pheasant, but there was no evidence that it did so. The eggs remained undisturbed in this deserted nest from 16 May to 19 June.

When hen pheasants left the nest with a brood, two of them had eggs remaining unhatched, containing live chicks that probably would have hatched within a few hours. The hen may thus exhibit a stronger attachment to her chicks and the desire to find food for them may be stronger than the desire to remain on the unhatched eggs.

DISCUSSION

Bent (1932) reported that pheasants lay 6 to 14 or 15 eggs, usually 10 to 12, and that they have been known to lay eggs in other birds' nests.

Ball (1952) reported three pheasant hens sitting on nests of 41, 32, and

36 eggs, respectively. He also reported that the average clutch size was 11.5 in 1947 and 11.2 in 1948.

Ten of the 11 nests observed in the present study had a full clutch of eggs. However, there is evidence that on at least three occasions, more than one hen may have contributed to the nest eggs. Excluding one incomplete nest of flooded eggs, there was an average of 16 eggs per nest. Even though the sample number of nests is quite small, the average number of eggs appears relatively high.

There may have been more than three nests in which two or more hens were depositing eggs. The nest containing 24 eggs was not discovered until all the eggs had been laid. More than one hen may have been contributing to the number of eggs in this nest.

Kabat et al. (1948) reported that gallinaceous birds often will drop single eggs away from a nest site before selecting the site for the bulk of their clutch. Perhaps some nests are relatively easy to discover by females that have not selected a nest site of their own. These may be used to deposit the few eggs that would have been dropped away from any nest site. Several single eggs were discovered in the nesting area, far from any nest. Also, the dropping of these single eggs may be primarily in the early part of the nesting season before birds are strongly stimulated to select nest sites. In this study, known extra eggs were laid in nests on 4 May and 5 May, 14 May and 19 May. Two other nests having 19 and 24 eggs had the full numbers on 25 May and 8 May, respectively.

Blain (1954) reported a pheasant nest containing quail eggs which was deserted by the pheasant. There were six pheasant eggs when first found. Then one pheasant egg and one quail egg were added each day until there were eight quail and 13 pheasant eggs. The pheasant then deserted the nest.

Bellrose et al. (1964) reported that female Wood Ducks desert a nest much quicker if more than one hen is laying in it. It appears that hen pheasants may act similarly.

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NEST CARD PROGRAM

The North American Nest Card Program is winding up the 1965 nesting season, and many cards have already been returned. There are still many cards in the hands of the individual recorders, however, and these should be returned to us as quickly as they are completed. We are preparing the data for transferral onto IBM cards, and a large bulk of material is needed for the first run, to be started soon.

Regional Centers may determine for their members whether their cooperators should return the cards to the center first, in order to complete local records, or whether they may be sent directly to us as they are completed.—*Laboratory of Ornithology, 33 Sapsucker Woods Road, Ithaca, N.Y.*

GENERAL NOTES

Swallow-tailed Kite and snake: an unusual encounter.—On the morning of 10 May 1964, Mr. Bailey Darley, who operates the fishing camp at the South Altamaha River, just off U.S. Highway 17, in McIntosh County, Georgia, saw a bird, unfamiliar to him, alight on the road nearby. The bird was fluttering one wing. He found that the bird had a small snake wrapped around the wing. With the aid of a stick he was able to get bird and snake into a wire poultry cage. He then reached in with a stick and got under the snake, which released its hold. Through Mr. George Geiger of the Georgia Fish and Game Department the word was passed on to Mr. Neil Hotchkiss, of the Patuxent Research Center, and he and Mr. Walter A. Harmer went over that day, and identified the bird as a Swallow-tailed Kite (*Elanoides forficatus*) and the snake as the keeled green snake (*Opheodrys aestivus*).

The following day, Mr. Brooke Meanley, also of the Patuxent Research Center, and I saw the bird and the reptile, and photographed the bird. It was an adult, in excellent plumage other than a minor amount of feather damage from the incident. Mr. Darley released the bird and the snake that same day. When released the kite flew toward the top of a nearby cypress, but was chased by two Mockingbirds and flew on off with no obvious damage.

Recent records of this kite in coastal Georgia are very few. Mr. Harmer, who is a biologist with the Georgia State Board of Health, has spent many years in the Altamaha River Delta and has never seen the species there before.

It is supposed that when the kite captured the snake in its claws, it wound around the wing enough to hamper flight. The bird was quite docile in captivity and accepted and ate a few small minnows offered to it on a straw or wire.—Ivan R. Tomkins, *1231 East 50th St., Savannah, Georgia, 21 July 1964.*

Piping Plover's nest containing eight eggs.—On 20 May 1964, we found a Piping Plover's (*Charadrius melodus*) nest containing eight eggs at Long Point, Norfolk County, Ontario (42°32′N, 80°07′W). An adult Piping Plover was seen incubating the eggs and appeared to be having some difficulty in covering them all. On 22 May the nest contained only seven eggs and by 27 May all had gone. It was suspected that Ring-billed Gulls (*Larus delawarensis*) were responsible for the loss of the eggs, as indicated by footprints around the nest.

Bent (1929. *U.S. Natl. Mus. Bull.*, 146:239) says "four eggs are the almost invariable rule with the Piping Plover; rarely only three are laid in second nests, and I have found one with five." Of 526 nests examined by Wilcox (1959. *Auk*, 76:129–152) on Long Island, New York, none contained more than four eggs; 448 contained 4 eggs, 70 contained 3 eggs, and 8 contained 2 eggs. Although it is probable that two females were responsible for the eight-egg clutch, no definite proof of this was obtained.—D. J. T. Hussell, *1916 Cambridge Road, Ann Arbor, Michigan,* and J. K. Woodford, *76 Glentworth Road, Willowdale, Ontario, (Contribution of the Long Point Bird Observatory), 8 September 1964.*

The status of the Ruff in North America.—In this note I present evidence suggesting that the Ruff (*Philomachus pugnax*) may be breeding in North America. The Ruff is by far the commonest of the palaearctic shorebirds that occur in North

TABLE 1

OCCURRENCES OF THE RUFF IN EASTERN NORTH AMERICA, 1953–63

	Dates														
	March	April		May		June		July		August		September		October	
	15–31	1–15	16–30	1–15	16–31	1–15	16–30	1–15	16–31	1–15	16–31	1–15	16–30	November	
Nova Scotia, Maine				1					3		1	1			
Ontario				1	1	2			5	1					
Mass., Rhode Is., New Hampshire			2	3	2			1	3	1	1	3		2	
New York, Pennsylvania		2	1	8	2	1		2	5	5	3	1	2	1	
New Jersey, Delaware		1	1	5				4	1	3	4			1	
Maryland, N. Carolina, Washington, D.C.	2							1	2				1		
Totals	2	3	4	18	5	3	0	8	19	10	9	5	3	4	

America. In 1963 there were thirty reports of this species in *Audubon Field Notes*. Its current status in eastern North America is that of a scarce, but regular, spring and fall transient. The lack of records from Florida, where shorebird concentrations are well checked, and the records from the Antilles (Bond, 1961. "Birds of the West Indies") suggest an overwater flight from and to South America with a landfall and departure in the general region of Cape Hatteras. The dated records of occurrence, taken from the last 10 years of *Audubon Field Notes*, are given in Table 1. The pattern of dates is that of a typical shorebird that winters in South America and breeds in the North. The question is, does the Ruff merely migrate with other shorebirds or does it breed in the North?

The route of entry from the Old World is of some importance in this discussion. Nisbet (1959. *Brit. Birds*, 52:205) and Eisenmann (1960. ibid., 53:136) have both argued a strong and convincing case for a tropical rather than a North Atlantic crossing. The basis of the argument is as follows:

(1.) If the crossing were via the North Atlantic one would expect that the species breeding in Iceland, Redshank (*T. totanus*) and Black-tailed Godwit (*L. limosa*), and other northern breeders would occur more frequently in North America than the Ruff, which is not especially common in northwestern Europe.

(2.) The Ruff is one of the commonest wintering shorebirds in West Africa.

(3.) The winds in the tropical Atlantic are generally favorable whereas those in the North Atlantic are generally unfavorable.

If we accept this theory, two possibilities exist: either the American population of the Ruff is frequently restocked via the tropical Atlantic crossing, or else the stock is maintained by breeding in North America. There are two pieces of evidence to support the latter. First it can be seen from Table 1 that there are more fall occurrences than spring. The reverse would be expected if the stock came solely from fall or wintering crossing of the tropical Atlantic. In Europe, the Pectoral Sandpiper (*Erolia melanotos*) occurs annually in the fall but few survive to reappear in the spring (Nisbet, loc. cit.). Second, there are a few records of immatures in the fall; these could only occur from breeding in the north or by the unlikely North Atlantic crossing. There are only a few recent specimens of fall birds in the major collections, and none of these are immatures. Two records of immatures have been reported in *Audubon Field Notes*: East Hampton, Long Island on 16 August 1955 (Shephard fide Nichols) and Chincoteague, Virginia, 19 July 1963 (Dyke and Scheider). On 9 July 1964, I saw an immature at Onondaga Lake, New York. Careful checking of fall birds to determine the number of immatures would add considerably to our knowledge of the status of this species.

The author is grateful to Dr. R. F. Andrle, Mr. Aaron Bagg, Mr. John Bull, Dr. T. Cade, Dr. F. Scheider, and Dr. Walter Spofford for information and advice in the preparation of this note.—David B. Peakall, *Upstate Medical Center, 766 Irving Avenue, Syracuse, New York, 16 October 1964.*

Common Crows catching European chafers on the wing.—At 8:00 PM on 30 June 1964, I noticed a large flock (250–300 birds) of Common Crows (*Corvus brachyrhynchos*) perching in and flying from a dead American elm (*Ulmus americanus*) which overlooked a treeless plot of the Mount Hope Cemetery in Rochester, New York. The flights of single birds to and from the tree seemed at first to be the normal activity of preroosting crows, but closer scrutiny revealed these crows to be in aerial pursuit of countless swarming brown insects. These were later identified by Dr. Edward Boardman, of the Rochester Museum of Arts and Sciences, as European chafers (*Amphimallon majalis* Raz.)

The adult chafers are flying beetles which swarm about foliage at dusk, humming like bees. The crows, in spite of their large size, were very dexterous in catching the chafers on the wing. The birds flew from the base perch, pursued the quarry, caught it while hovering, and returned to the perch, all with the finesse of a flycatcher.

The European chafer, a beetle of the family Scarabaeidae, was introduced into this country about 25 years ago. It is a close relative of many native species of "June Bug," as well as the Japanese beetle, Oriental beetle, and Asiatic garden beetle. The larval stage of the chafer is injurious to the roots of most grasses.

Acknowledgment.—I am most grateful to Dr. Foster Gambrell of the New York State Agricultural Experiment Station, Geneva, N.Y. for his assistance in supplying information about the European chafer.—Dwight R. Chamberlain, *School of Forestry and Wildlife, Virginia Polytechnic Institute, Blacksburg, Virginia, 22 August 1964.*

An observation of heavy predation by Pearly-eyed Thrasher.—On numerous occasions I have seen Pearly-eyed Thrashers (*Margarops fuscatus*) eating small birds and house mice (*Mus musculus*), and occasionally have seen them feeding upon rats (*Rattus*). The prey is usually impaled on a wire or thorn and at times is even lodged in a crotch

FIG. 1. One whole and one partially consumed body of *Rattus* sp. in a growth of *Helaconia caribea* and *Alamanda cathartica.*

of a tree or shrub, similar to the custom of shrikes (*Lanius*). A thrasher may return to its cache for a second or even third morsel, for it by no means always consumes its prey at the first feeding. Some food may even be eaten over a lapse of two consecutive days.

The most interesting example of the predatory habits in this species was an occurrence on the campus of the University of Puerto Rico at Mayaguez, where the whole or partially consumed bodies of 13 rats were found in a small area covered with a growth of *Alamanda cathartica* and *Helaconia caribea.* The rats were all of the albino laboratory variety, which presumably had escaped from cages. Observations over a period of several hours on three consecutive days indicated that only one thrasher was involved in this predation.—FRANCIS J. ROLLE, *Museum of Biology, University of Puerto Rico, Rio Piedras, Puerto Rico, 24 September 1964.*

Range extension of the Fish Crow in Missouri.—On 30 March 1964, at Big Oak Tree State Park, Mississippi County, in the boot-heel of Missouri, Dennis Marquis and writer observed and heard calling two Fish Crows (*Corvus ossifragus*). The writer is familiar with this species in Florida and the earliness of the season eliminated any confusion with young Common Crows (*Corvus brachyrhynchos*).

This seems to have been the first observation for Missouri, although the species has been reported by several members of the St. Louis Audubon Society during the last three summers along the Mississippi River south of St. Louis, Illinois (1962. *Bluebird*, 29:27).

That the Fish Crow has not been previously reported in Missouri seems surprising since it is found in every major drainage in Arkansas (1962. *Audubon Field Notes*, 16:338; 1957. AOU Check-list, p. 380) and in southwestern Tennessee (1957. AOU Check-list, p. 380). The abundance of this species at Memphis, Tennessee, is apparent from the 1962 Christmas Bird Count where 74 where recorded (1962. *Audubon Field Notes*, 16:195).

David H. Snyder, professor of biology at Austin Peay State College, Clarksville, Tennessee, reports in correspondence that he has observed the Fish Crow at Reelfoot Lake (nw. Tennessee) during March and May. In late March 1962, Wally George and the writer observed and heard Fish Crows at this location. As the crow flies, Reelfoot Lake would be no more than 14 miles from Big Oak Tree State Park, Missouri.

Richard Anderson of St. Louis, Missouri, informs me that he and James Haw observed several Fish Crows at Charlestown, Missouri, and Big Oak Tree State Park on 12 September 1964.

On 9 June 1965, at Big Oak Tree State Park, the writer was successful in collecting an adult male Fish Crow while it was calling. The bird was definitely in breeding condition (testes—16 × 12 mm) and several other family groups were observed in the same area. The measurements and glossy coloration were typical of the species and comparison with specimens at the University of Kansas confirmed identity. The specimen was preserved as a study skin, D.A.E. #902. Thanks are extended to Dr. Richard F. Johnston, University of Kansas, for allowing examination of specimens.—David A. Easterla, *Department of Biology, Northwest Missouri State College, Maryville, Missouri, 8 October 1964.*

A new subspecies of *Icterus prosthemelas* from Panamá and Costa Rica.—Recently the authors have had the opportunity to compare series of *Icterus prosthemelas* from throughout the species' range. We find that the population of the Caribbean slope of Costa Rica and adjacent Panamá represents an undescribed subspecies based on the juvenal plumage. This population may be known as:

Icterus prosthemelas praecox new subspecies

Type. Juvenile male, No. 392316, American Museum of Natural History; taken at Almirante, Bocas del Toro Province, western Panamá, 22 August 1927, by R. R. Benson (original field no. 797).

Diagnosis. Juvenal plumage similar to that of *I. p. prosthemelas*, but with the black of the throat patch more extensive, extending onto the lower breast, and the interscapular region solid black, instead of yellow-green. No differences in any of the postjuvenal plumages, or in size.

Discussion. Five juveniles from Costa Rica (Estrella Valley 2, Guápiles 1, and Naranjo 1) and Panamá (the type) are uniform in the characters described above, and differ from 21 juveniles from north of Nicaragua. Two juveniles from Nicaragua (Río Escondido and Segovia River) and one from Honduras (La Ceiba) have some entirely black feathers in the interscapular region, and three of the four show a narrow extension of black onto the lower breast. They are thus somewhat intermediate. Juvenile *prosthemelas* from Guatemala and México have at most only narrow black tipping on the interscapular feathers in some individuals.

The description of a new subspecies based solely on the juvenal plumage may be questioned by some ornithologists. To these we would point out the large number of forms the world over that have been described only on the basis of the adult male definitive plumage (*Icterus fuertesi*), or adult female definitive plumage (*Agelaius*

spp.), or even the male definitive alternate plumage (*Dendroica petechia* subspp. and *Vidua paradisaea* subspp.). Each of these plumages, like the juvenal plumage, is genetically controlled and presents characters which identify local populations. Moreover, each of these definitive plumages is found only on a minority of the birds of any one population. On the other hand, every living bird in the population has passed through the juvenal plumage, albeit the latter is usually worn for only a short period of time and is seldom adequately represented in museum collections. These are not valid arguments against the use of the juvenal plumage (or any other particular plumage) as the principal taxonomic character of a subspecies.

Acknowledgments. We wish to thank the curators of the following institutions for kindly lending us specimens in their care: American Museum of Natural History; Carnegie Museum; Museum of Comparative Zoology; Peabody Museum, Yale University; United States National Museum; and the University of Minnesota Museum of Natural History. Dr. Dean Amadon placed the facilities of the American Museum of Natural History at the authors' disposal; and Phillips was generously supported by a grant from the Frank M. Chapman Fund, permitting him to carry out extensive research at the museum.—Allan R. Phillips, *Instituto de Biología, Universidad Nacional Autónoma de México, México, D.F.*, and Robert W. Dickerman, *Department of Microbiology, Cornell University Medical College, New York, New York, 5 January 1965.*

ORNITHOLOGICAL NEWS

FROM THE AOU

At its annual meeting in Columbus, Ohio on 23 August 1965 the AOU elected the following officers:

Dean Amadon, President
Harold Mayfield, First Vice-President
Thomas R. Howell, Second Vice-President
L. Richard Mewaldt, Secretary
Burt L. Monroe, Sr., Treasurer
Robert M. Mengel, Editor

and elected members of the Council: James L. Baillie, Eugene Eisenmann, and Robert J. Newman.

The Brewster Medal was awarded to Ernst Mayr.

Research on members of the family Ardeidae seems to be quite popular. The following requests for assistance have been received.

Dr. Andrew J. Meyerriecks, Department of Zoology, University of South Florida, Tampa, is studying the dispersal of newly fledged herons from central and southern Florida. The work is being done in cooperation with the Encephalitis Research Center, Tampa, Florida. All herons are banded and part of their plumage is dyed a bright color. Each major heronry has been assigned a color code. If you see an unusually colored heron of any species please send the following information to the address listed below: DATE; PLACE; SPECIES (if known); COLOR; HOW HERON WAS COLORED (e.g., right or left wing only, both wings, belly, etc.). Please send your name and address with your record to: *Heron Project, Encephalitis Research Center, 4001 Tampa Bay Blvd., Tampa, Florida.*

Robert C. Paulson, Jr. of Cedar Falls, Iowa is working on a project concerned with the summer and year-round distribution of the Green Heron and the Black-crowned Night Heron. He wishes persons who sight marked birds of these two species to report the sightings. The birds are marked in one or more of the following ways: aluminum government band; colored leg band; and in some cases a "back saddle" and/or dyed feather patches. Information desired on each sighting includes: exact location; habitat; behavior; exact time of observation; number of bands on legs; unusual color patterns visible; if the bird is not alone, the number of other herons with it; species; observer's name and address. Information is to be sent to: *Robert C. Paulson, Jr., 2504 College Street, Cedar Rapids, Iowa 50613.*

T. A. Beckett III of Magnolia Gardens, South Carolina and his associates have banded nearly 2,000 Cattle Egrets within a 15-mile radius of Charleston, S.C. This season these birds were banded with aluminum government bands on the right leg, and a red band on the left. It is requested that all sightings of these birds be reported to T. A. Beckett III, Magnolia Gardens, Johns Island, S.C.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

This grant, established in 1947, is devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge.

An anonymous donor gave $500 to found the fund: later donors have provided some $600. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually.

Although grantees are not required to publish their studies in *The Wilson Bulletin*, it is hoped that they will submit their manuscripts to the Editor of the *Bulletin* for consideration.

Since its inception the Fuertes Research Grant has been awarded to 20 persons, many of whom have continued their research work. The recipients are listed below.

1948—Leonard R. Mewaldt, Life history of Clark's Nutcracker.

1949—Stephen W. Eaton, A comparative study of the genus *Seiurus*.

1950—Henry E. Childs, Population dynamics and life history of the Brown Towhee.
Byron E. Harrell, Ecology of Rancho del Cielo, Tamaulipas, Mexico.
Arnold J. Peterson, Reproductive cycle in the Bank Swallow.
Harrison B. Tordoff, Comparative osteology of the subfamilies of the Fringillidae.

1951—Howard L. Cogswell, Territory size and its relation to vegetation, structure, and density among birds of the chaparral.

1952—Robert W. Nero, Territorial and sexual behavior in the Red-wing.

1953—No award.

1954—William C. Dilger, The isolating mechanisms and relationships of the thrush genus *Hylocichla*.

1955—Robert G. Wolk, Analysis of reproductive behavior in the Black Skimmer.

1956—John B. Millar, An investigation of possible factors involved in the initiation of migration.
Lester L. Short, Jr., Hybridization and isolating mechanisms in North American flickers.

1957—Millicent (Mrs. Robert L.) Fieken, Comparative study of the behavior of the Canada Warbler and the Redstart.

1958—Harold D. Mahan, Studies of growth and temperature regulation in the Red-wing.

1959—No award.

1960—Robert T. Lynn, Comparative behavior of the Carolina and Bewick's Wrens.

1961—Francis C. (Mrs. Douglas A.) James, The birds of Arkansas.

1962—Donald S. Heintzelman, Life history of the Sparrow Hawk.

1963—Nicholas Verbeek, Breeding biology of the Water Pipit.

1964—Robert E. Gobeil, Arterial system of the Herring Gull.

1965—John O. Sullivan, Ecology of the Dipper, *Cinclus mexicanus*.

Application forms may be obtained from Harrison B. Tordoff, Museum of Zoology, University of Michigan, Ann Arbor, Michigan. Completed applications must be received by 1 March 1966.

ORNITHOLOGICAL LITERATURE

BIRDS OF PREY OF THE WORLD. By Mary Louise Grossman and John Hamlet. Clarkson N. Potter, Inc., New York, 1964: 9½ × 12¾ in., 496 pp., 70 col. photos. by Shelly Grossman, many other illus. $25.00.

The birds of prey are among the most awesome, superb, and misunderstood creatures of nature, and nearly all students of birds count them among their most esteemed objects of study. I have often been impressed by the large number of ornithologists—amateur and professional alike—who name the Peregrine Falcon as their favorite bird, a sad commentary in this day of its rapid disappearance in the more polluted parts of the world. Indeed, as this book by Grossman and Hamlet documents very well, man's emotional, intellectual, artistic, and recreational involvement with the birds of prey pervades all cultures and undoubtedly had its origin in the remote ancestry of the human intellect.

This large, sumptuous volume, which attempts to cover every living species of Falconiformes and Strigiformes, is well designed to excite the interest and acquisitiveness of all devotees of the raptors. One reads on the jacket that: "This is the most complete, authoritative and exciting book ever produced on the world's most dramatic birds—the two orders of raptors, the hawklike birds and the owls . . . This work, of vast scope, contains 70 full-color photographs illustrating 45 species of birds, and 283 photographs in duotone. In addition, there are 425 range maps of the individual species, 646 flight silhouettes of the hawklike birds, and several other special features, including line drawings of species never before figured, and a unique color chart which is the key to the color names used in all descriptions of the birds."

Such a comprehensive treatment has been needed for a long time. Unfortunately, this this 25-dollar book sometimes gives the impression of having been put together more for the enrichment of the authors and publisher than for the edification of its readers.

Judged by the old Chinese criterion, the illustrations in this lavishly pictorial volume should be worth more than a million and a half works—seemingly a rare value at the price—but I question how many of the thousand words evoked by the color photograph of a disheveled and awkwardly posed Lesser Kestrel (opposite p. 64) add up to esthetic or intellectual satisfaction for the viewer. I wonder even more about the thousand words called forth by the same picture printed in reverse in black and white on page 403. This egregious sort of duplication occurs all too often in the book and undoubtedly added considerably to the cost of publication.

Most of the photographs, by Shelly Grossman, are of captive birds—either caged specimens in zoo collections or individuals kept tethered to outdoor perches at John Hamlet's former exhibition of living raptors near Ocala, Florida, where at one time he had assembled more than a hundred species. Although these photographs are executed with a fair degree of technical skill, the esthetic quality of many of the pictures is marred by the appearance of broken wing and tail feathers, overgrown beaks and talons, and scarred ceres and tarsi, defects all too often associated with raptors kept in captivity. Even when the birds are in good physical condition, they often appear unkempt and unnaturally awkward—almost stuffed—because they were evidently still rather wild when handled and were not permitted to relax and shake out their feathers before being photographed. Typical examples are the Lesser Kestrel referred to above, the Plumbeous Kite opposite page 161, and the Screech Owls opposite page 182.

The head and shoulder portraits are by far the best efforts among the color plates. Some are really outstanding representations of bird photography, such as the African

White-headed Vulture (following p. 112), the Barn Owl (following p. 144), the King Vulture (following p. 160), and the Pondicherry Vulture (preceding p. 183). A discriminating publisher might well have restricted the costly, full-page color plates to include only these portraits of high quality.

Incidentally, some of the best black-and-white photographs were taken by Eric Hosking and Heinz Meng.

For the most part, the "action shots" are highly informative, and entirely appropriate advantage has been taken of the opportunity to use Hamlet's trained birds for many of these pictures. Each shows some functional aspect of birds in general or of raptors in particular, as for instance, in the excellent sequences depicting a Red-tailed Hawk taking off from a perch, flying, and attacking a pheasant, and the African Brown Harrier-Eagle attacking, killing, and eating a snake. But some of the pictures showing acts of predation border on the bizarre and depict events barely possible in nature; for instance, the series on a Great Horned Owl attacking an oversized snake, the Red-tailed Hawk attacking and killing a full-grown opossum, and the American Kestrel attacking a woodrat. More typical quarries could have been used with equally dramatic effects.

At best, the birds of prey are difficult subjects for portrayal by camera or by brush and paint. The only two bird artists ever to achieve real success with the falconiforms, in my opinion, were Louis Agassiz Fuertes and George E. Lodge. The now classic photograph by Arthur A. Allen of the old Peregrine Falcon at Taughannock Falls represents the height which can be reached with the camera. With a few exceptions, the illustrations in this book fall far short of the standards set by these predecessors.

The text is divided into two parts. The first section consists of five chapters entitled. Prehistory, Birds of Prey and Men, Ecology and Habits, Designs for Survival, and Conservation. The level of presentation and general quality of these chapters range from elementary and sophomoric (ecology and habits) to sophisticated and scholarly (birds of prey and men). The chapter on prehistory briefly summarizes what is known about the evolution of birds, with special attention given to fossil representatives of the Falconiformes and Strigiformes. Chapter 2 on the relations between raptors and man is excellent. Man's superstitious, religious, artistic, literary, recreational, and nationalistic preoccupations with raptors are surveyed from earliest history to modern times and from primitive cultures through advanced civilizations. The photographic copies of various art objects, paintings, artifacts, and coins depicting birds of prey complement the text of this chapter in a most effective and informative way. The chapter on ecology and habits is rather disappointing, because of its oversimplified and uncritical generalizations. The adaptive specializations of raptors for predatory modes of existence are described in simple but interesting language in the chapter on designs for survival. The final chapter on conservation is timely—including a presentation of the current problem of pesticide effects on raptors such as the Bald Eagle, Golden Eagle, Osprey, and Peregrine Falcon—in good taste, and to the point.

The second half of the book takes up a systematic treatment of 289 species of Falconiformes and 133 species of Strigiformes. Each genus is described in non-technical language, and at least one representative of each is depicted either by a black-and-white photograph or by a linedrawing by Jo McManus. The latter were drawn from museum specimens and bear little resemblance to lifelike forms. In addition, there is usually a short description of each species within a genus, and in the case of the falconiforms there are one or more small flight silhouettes of each species. The utility of this type of illustration for field books on identification is indisputable, but silhouettes add little

of value to a book of this scope. Moreover, many of them are badly proportioned and show little similarity to the silhouettes of living birds in flight.

There is also a distribution map for each species, showing the "approximate breeding range." The reader is left uninformed, however, about the sources of information used in mapping breeding ranges, and consequently there is no way to judge their accuracy. Some of those with which I am personally familiar, like that of the Gyrfalcon in Alaska, are not correctly indicated. A section on "habits" under each genus summarizes salient details about the life histories of the included species.

The list of acknowledgments indicates that the manuscript for the book must have been subjected to the scrutiny of a rather formidable array of consultants, and consequently there are relatively few gross errors of fact. Some misstatements which caught my attention follow. Being the westernmost representatives of the Pueblo group, the Hopi Indians referred to on page 45 live in Arizona not, as stated, in New Mexico. On page 122, Niko Tinbergen is given credit for the classic Dutch work on predation by the European Sparrowhawk, whereas it was actually done by L. Tinbergen; nor is the reference cited in the bibliography. The gist of R. W. Storer's hypothesis to explain sexual dimorphism in size among falconiforms involves intraspecific rather than interspecific competition, as stated on page 239. On page 270, the upper silhouette of *Buteo lagopus* represents the immature plumage and not the "common phase" of the adult as stated in the caption. Two pounds is given as the approximate weight of the Gyrfalcon on page 388, but in fact females typically weigh more than 3 pounds, and some individuals exceed 4.

By and large this book is a sympathetic attempt to portray the birds of prey of the world in ecological perspective. One encounters few of the grotesque or sensational statements so often associated with "popular" accounts of these birds. The only blatant one which I came across is on page 134 where one reads in a section on the Great Horned Owl that "Forest Service personnel wearing muskrat hats are in peril of being attacked, and in one or two instances a ranger has been blinded or killed by the sharp and deeply penetrating talons of *Bubo*." Surely such a statement demands the most scrupulous documentation before it is included in a book which is bound to be widely accepted and quoted as authoritative.

The most serious reservation I have about this book relates to the authors' extreme laxity in citing the sources of their information. Although it would perhaps be difficult to draw a sharp distinction between creative scholarship and plagiarism in an ostensibly popular treatment of a body of scientific knowledge, the authors of this book have certainly shown too casual a regard for acknowledging the work of others. It is not enough to say in the introduction that thousands of references have been consulted. At the least, the authors should have included in their bibliography all references from which they took specific, substantive information. Not only is this the minimum demand of ethics and courtesy among scholars, it is also a definite aid to the interested reader who may wish to pursue the subject to its original source. For instance, on page 257 one reads in connection with nest-building that, "The Gabar Goshawk transports spiders along with their webs, and the spiders continue to weave gossamer around the small structure of sticks and twigs." Now, that is a most interesting piece of information, and any curious reader might wish to know the original source. On page 13, the reader is told that, "If a reference cannot be traced to one of the standard bird guides, it may be found in an article or manuscript under the scientific name (Latinized binomial) of the species." Aside from the obvious inconvenience of having to search through all possibly pertinent references listed, the real catch is in the words "may be." It may be

found, but it also may not be found at all. The authors say (p. 13) that they "have supplied as complete a Bibliography on the birds of prey as possible," and yet there are numerous cases in which they failed to include references from which they obtained information. Since the bibliography contains only about 450 citations, the potentialities inherent in the existing literature on raptors were not even broached. I am tempted to ask how many pages of bibliography could have been published for the cost of the eight unnecessary color plates of the Horned Owl following page 31.

Again on page 13 the authors "caution the reader that, in a broad synthesis such as this, footnotes, and with few exceptions, in-text references must be sacrificed to continuity." In any work which summarizes technical literature, the continuity which may be lost by proper citation is more than compensated by the increased confidence instilled in the critical reader when he knows the sources which have been used.

Still needed in the subject area covered by this book is an authoritative review of the families, genera, and species of Falconiformes, presented within the scope of modern phylogenetic principles, with an up-to-date technical diagnosis of each taxon and a discussion of the presently accepted limits of each, and a well-documented summary of the known biology of each species. The authors and publisher of such a book might well consider including only those illustrations which have utility in imparting information about functional and comparative morphology, phylogeny, habitat, behavior, or other pertinent biological details, instead of decorating their pages with "pretty pictures of birds" and incidentally doubling or tripling the cost of publication.—Tom J. Cade.

The Waterfowl of the World. Volume Four. By Jean Delacour, with contributions by Hildegarde Howard, Milton W. Weller, Philip S. Humphrey, and George A. Clark, Jr. Country Life Limited, London, 1964: 8 × 10 in., 364 pp., 6 col. pls. by Peter Scott, figs., maps. 6 guineas.

When publication of this series began in 1954, the author anticipated that the full set would consist of three volumes, and he stated in his introduction to the first volume: "A general account of the family *Anatidae* will be given at the end of the last volume. It will include chapters on morphological, anatomical, and biological characters; on history, sport, conservation, acclimatization, care and breeding, and a bibliography." It became apparent as the project progressed that the species accounts would fill the originally proposed three volumes, and that a fourth, supplemental volume would be needed for the "general account of the family." Reviewers who were disappointed at the superficiality of treatment of some aspects of the waterfowl in the first three volumes had to hedge their statements, as nobody knew just what the fourth volume would be like. It has now appeared, and, as we had hoped, greatly augments the usefulness of the work as a whole.

Although few living ornithologists share Delacour's familiarity with waterfowl in general, his interest in and knowledge of the group have nevertheless been somewhat specialized. Reviewers of the first three volumes commented on the emphasis (considered undue by some) on aviculture, and Delacour has also paid much attention to taxonomy, especially at the generic and higher levels. For the fourth volume of his work, he called upon a group of specialists to write chapters supplementing his own on aviculture, domestic waterfowl, and additions and corrections to the first three volumes. The first six chapters were written by Milton W. Weller; these are entitled General Habits, The Reproductive Cycle, Ecology, Distribution and Species Relationships, Fowling, and Conservation and Management. Philip S. Humphrey and George A. Clark, Jr. contributed

a chapter on the Anatomy of Waterfowl, and Hildegarde Howard one on Fossil Anseriformes. It has become a cliché of reviewing to say that such multiplicity of authorship leads to unevenness of treatment, and the present volume is no exception.

Delacour's introduction states "A list of corrections and additions terminates this volume, bringing up to date our present knowledge of the Family *Anatidae* at the beginning of 1963." In view of the size of the annual increment of literature on the waterfowl, it would have been desirable for authors of the individual chapters (which have separate bibliographies) to indicate their closing dates. Delacour's statement obviously applies only to his supplementary chapter; Dr. Howard, for example, mentions Woolfenden's important paper on postcranial osteology of waterfowl (1961. *Bull. Florida State Mus., Biol. Sci.*, 6:1–129), but states: "Unfortunately Dr. Woolfenden's thesis was not completed when most of the work involved in the present chapter on fossils was under way." The bibliographies of Chapters 1 and 2 list no paper later than 1960, except for a single 1962 reference in Chapter 1 which may well have been added in proof. Similarly, the chapter on anatomy was obviously completed before "the beginning of 1963," as Johnsgard's paper on the taxonomic significance of tracheal anatomy (1961. 12th *Ann. Rept. Wildfowl Trust.* pp. 58–69) is not cited. Even Delacour's chapter does not pretend to be a guide to the major literature of the waterfowl subsequent to the appearance of the earlier volumes of his work. The emphasis is on aviculture, on new evidence pertaining to classification, and newly published life history material on a few poorly known species. Many major papers on waterfowl published prior to 1963 have not been utilized at all.

Weller's chapters are, by and large, workmanlike and useful summaries, well documented with references to excellent bibliographies. Proofreading of these chapters, however, was not as thorough as in other parts of the volume. For example, the name Witschi appears as "Witchie" on page 39, and as "Wischi" in the bibliography of Chapter 2 (p. 79). *Sarkidiornis* becomes "*Sarkiornis*" on page 111, and *octosetacens* "*octosetaceons*" on the facing page. Ridgway's name is misspelled on page 80, and Crissey's on page 135.

Reviewers of the earlier volumes (cf. Elder, 1955. *Wilson Bull.*, 67:314–317: Storer, 1956. *Auk*, 73:298–299) were disappointed in the lack of descriptions of displays of individual species in spite of the abundant literature on this subject and the importance placed on behavioral characters in classification by Delacour himself. Weller has cited many important papers, but because of severe space limitations, was able to give descriptions of the displays of only five "representative species." These paragraphs are, rather inconsistently, headed "*Branta canadensis*," "*Anas platyrhynchos*," "*Aythya vallisneria* [*sic*]," "Goldeneye," and "North American Ruddy Duck." Storer's hope for "a series of sketches and descriptions of the characteristic displays of each group of species. . .[in] one of the remaining volumes" has not been fulfilled.

Chapter 4, Distribution and Species Relationships, is a short (13 pages) and, in this reviewer's opinion, largely superfluous treatment of a miscellany of subjects. There are eight world maps showing distribution of five tribes and three major genera, and four tables summarizing distributional information. It must be re-emphasized that such summaries (and, indeed, the maps) can only be approximations because of genuine disagreement among taxonomists as to species and genus limits, and tribal placement of certain species. All too often such maps and tables are presented as if the underlying taxonomy were the last word. Table I, for example, listing the distribution of the Anatidae by faunal regions, would display a radically different set of figures for endemic genera and species had it been based on the work of an author less of a "lumper" than Delacour.

In Chapter 5, Weller presents a brief and useful history of fowling methods, and, in Chapter 6, an authoritative survey of conservation and management of waterfowl. It is somewhat surprising in the latter to find no mention of that currently flourishing phenomenon, the controlled private shooting preserve, where the urge to kill can, for a fee, be expended on what the preserve owners themselves insist are "domestic" Mallards.

Delacour's chapters on aviculture and domestic waterfowl are, as we might expect, thorough and authoritative. The former chapter might well have included information on sources for obtaining waterfowl; absent from the list of periodicals, for instance, are such publications as the *Game Bird Breeders, Pheasant Fanciers and Aviculturalists' Gazette*, which regularly carry advertisements of waterfowl for sale or exchange. Also missing is mention of legal or licensing aspects of the transportation and keeping of wild species of waterfowl, certainly important in the United States.

By far the most scholarly contributions in this volume are the chapters on anatomy by Humphrey and Clark, and on fossil waterfowl by Howard. In the former, one finds the refreshing and all-too-rare admission that "limits of time, space, and knowledge have led us to present a rather uneven review which is necessarily incomplete and reflects to a great extent our own particular areas of study (pterylosis, trachea, molts)." Nevertheless, this 66-page chapter should be highly useful; it is well documented with citations to a bibliography condensed from one of over 1,000 titles compiled by the authors. References in the present work are arranged conveniently by organ system. Special attention should be called to the excellence of the illustrations in this chapter, all drawn (or redrawn from previously published figures) by Shirley Hartman.

Hildegarde Howard's chapter on fossil Anseriformes contains probably the greatest proportion of original work in the book. It is by no means a mere compilation from the literature; Dr. Howard re-evaluated the entire classification of fossil waterfowl, including re-examination of much type material unstudied since the 19th Century. The chapter begins with a nominal list of waterfowl, both extinct and living species, known as fossils. Then comes a summary of the geologic history of the group, with species lists for each epoch. This is followed by a complete account of every extinct species known at the time of writing (complete with synonymy, diagnosis, measurements, etc.), and a brief discussion of each extant species known from the fossil record. This chapter is also excellently illustrated, with both line drawings and halftones of bones. Several points of classification differ from the treatment in Brodkorb's catalogue of fossil birds (part 2, 1964. *Bull. Florida State Mus., Biol. Sci.*, 8:195–335), but these merely reflect differences in taxonomic viewpoint. On one point of nomenclature, Brodkorb appears to be correct: a subfamily name based on the generic name *Romainvillia* should be spelled Romainvilliinae, rather than "Romainvillinae" as Howard has spelled it.

The final chapter, by Delacour, covers "corrections and additions" to the first three volumes. As mentioned above, this is by no means a synopsis of the important recent literature on waterfowl, but is weighted heavily toward new avicultural information and new data affecting taxonomy. Unlike the other chapters, there is no separate bibliography, all citations being in the text. This is somewhat annoying, as the reader is forced to trace "*loc. cit.*" back to the first citation, in one case 27 pages earlier. The citations themselves are sometimes inaccurate or incomplete; on page 327 some information is attributed to "A. Hoogerserf [error for Hoogerwerf], 1959, pp. 192–199," but there is no further reference and no bibliography for the reader who wishes to consult Hoogerwerf firsthand. Banko's monograph on the Trumpeter Swan is cited (p. 331) as "North Am. Wild. Found., 63, Washington"; it is, of course, *North American Fauna* No. 63, published by the U.S. Fish and Wildlife Service.

Delacour cites the work of Woolfenden, Johnsgard, and others who have recommended changes in classification based on their detailed studies of certain aspects of the waterfowl. While acknowledging the importance of their work, Delacour in most cases does not accept their findings, often offering no contrary evidence other than a statement such as "However important these differences are, they do not seem to be sufficient; and we prefer to keep this species in the genus *Branta*" (p. 333). This is all the more irritating in that there is no indication as to the identity of "we"; the chapter is signed by Delacour alone. It might be thought that Peter Scott was included in the "we," as Scott has often (wrongly) been listed as co-author of "The Waterfowl of the World." Evidence against this theory lies in Delacour's refusal to admit the subspecies *Anas discors orphna* Stewart and Aldrich (p. 342), while Scott (1961. "A Coloured Key to the Wildfowl of the World," pp. 56–57) both accepts and figures this subspecies. If the taxonomic opinions presented in Delacour's "addenda" chapter were jointly arrived at, the reader has a right to learn the identity of the collaborator. If not, the use of "we" is, to say the least, misleading.

Peter Scott has contributed six color plates to this final volume of the series. The frontispiece is an impressionistic treatment of "Shovelers at Dusk" in Scott's well-known style. There are four plates illustrating domestic breeds of ducks and geese. Finally, there is a plate correcting errors in the color plates of previous volumes. A few of these corrections are explained in the text of the final chapter; most are not.

I ended my review of Volume 3 of this series (1960. *Wilson Bull.*, 72: 413) by mentioning that "the promised fourth volume is to remedy some of the shortcomings of the first three," and went on to say "Although the text thus far contains much of interest and usefulness, viewed in the light of Captain Delacour's international reputation as an authority on waterfowl it can only be characterized as disappointing." The material in Volume 4 on the waterfowl as a whole adds immeasurably to the value of this set as a reference work, but criticisms of the text of the first three volumes, insofar as the individual species accounts are concerned, have been alleviated scarcely at all by anything in Volume 4.—Kenneth C. Parkes.

Thoreau on Birds. By Helen Cruickshank. McGraw-Hill Book Company, New York, 1964: 10 × 7 in., 331 pp., 17 illus. $7.95.

Surely the time is past when a serious critic, be he scientist or nonscientist, can dismiss Henry Thoreau's nature writings as lightly as John Burroughs did in *Century Magazine* (1882): "To the last his ornithology was not quite sure, not quite trustworthy." Or disparage him as Havelock Ellis did in *The New Spirit* (1890) where he maintained that Thoreau's science "is that of a fairly intelligent school boy—a counting of birds' eggs and a running after squirrels." Charles D. Stewart answered Burroughs' charges in *Atlantic* (1935): "Thoreau had a faculty, which Burroughs does not seem to admire or understand, of the modern research worker." And Mark Van Doren in "Thoreau" (1916) remarked that "Mr. Burroughs has never been quite able to understand what Thoreau was doing."

After the publication in 1904 of Bradford Torrey's edition of Thoreau's "Journal," critical opinion underwent a significant change. McAtee in *Scientific Monthly* (1939), for all his reservations, found that, in ideas of protective adaptation, Thoreau preceded Belt, Wallace, and Darwin. Deevey in *Quarterly Review of Biology* (1942) suggests that Thoreau is "the first American limnologist." Adams in *Scientific Monthly* (1945)

regards him as an ecologist, Leopold and Jones in *Ecological Monographs* (1947) call him the "father of phenology," and Oehser in *Nature Magazine* (1945), recalling that, along with George Catlin, Thoreau was one of the first to suggest the establishment of a wilderness area as we think of it today, is convinced that "perhaps Thoreau was America's first real conservationist." What is noteworthy is that the recognition of these broad horizons of Thoreau's thinking appears not in the literary journals but in the scientific.

One of the early accounts of Thoreau and birds was Francis H. Allen's edition of Thoreau's "Notes on New England Birds" (1910); the latest to appear and perhaps the best is Helen Cruickshank's "Thoreau on Birds." It is a most attractive volume, illustrated with facsimiles from Wilson's "American Ornithology" and Nuttall's "Manual." The major portion of the volume, "Some Species of Birds from Thoreau's Journal," deals with Thoreau's notes on 103 species in the Concord vicinity. For each species there is an introductory section and excerpts from the Journal arranged in diary fashion as to month, day, and year. The selections are annotated with transitional passages set off in brackets. By and large, the transitions are judiciously executed. Occasionally they contain images which have their own integrity. Many of the Journal entries are put into the context of what seems to be Thoreau's knowledge of the species—an important addition. Useful too are the cross-references to many species in volumes other than the Journal. Nevertheless, these transitional commentaries sometimes lean toward the cumbersome, impeding the reader's progress and encouraging him to leap over the transitions to rejoin Thoreau's own lively flow of observation. Perhaps such information as range, distribution, and certain descriptive features might be left to the handbooks. Along with Journal excerpts are descriptions of birds in such volumes as "Walden" and "A Week on the Concord." A list of Thoreau's birds with the most recent designations clarifies such popular names as "Yorrick," "Belcher-squelcher" (for the American Bittern), and "Election-bird." This is by far the most comprehensive annotated compilation of Thoreau's birds available today. It naturally does not consider Thoreau's writing on birds in terms of zoological significance or contributions to ornithology as Deevey does for Thoreau's notes on limnology, Leopold and Jones for his phenological observations, or Adams for his ecological notations. Such a study would appear to be in order. As Roger Tory Peterson observes in a perceptive Foreword, "The measure of a man is his durability."

Mrs. Cruickshank has chosen the selections with a sure and discriminative taste. They illustrate Thoreau's careful recording of the behavior of birds. More than that, they underscore his passion for collecting and journalizing his data, his endless quest for facts. It is a pity to mention typographical errors, those skulkers in the blindspots of the proofreader's eye: "*orysivorous*" (p. 170), "*gentillis*" (p. 315), "*Progna*" (p. 316), "*Toxostroma*" and "*pyrrhonta*" (p. 320), "*Philchela*," and "*cictotherus*" (p. 321).

This compilation seems to derive entirely from Torrey's edition of the Journal. It might have been useful to examine the original manuscript notebooks. Excellent as Torrey's edition is, the Journal now probably requires a more scrupulous and definitive treatment with the variant revisions. As Philip and Kathryn Whitford pointed out in *Scientific Monthly* (1951), Torrey omitted important sections, such as the physiography of the Concord River. And Perry Miller in "Consciousness in Concord" (1958) adds that Torrey did not always use the most felicitous revisions found in Thoreau's notebooks for the 14-volume edition of the Journal. In fact, Miller calls some of Torrey's choices "a bit capricious."

All in all, Mrs. Cruickshank's book comes pretty close to being the definitive gathering

of Thoreau's observations on birds. One puts it down with a sense of agreement with the Whitfords (ibid.) that "modern scientists have gradually come to claim Thoreau as one of themselves."—Herbert Krause.

The Birds of Costa Rica: Distribution and Ecology. By Paul Slud. Bulletin of the American Museum of Natural History, New York, Vol. 128, 1964: 7⅝ × 10⅝ in., 3 maps. $10.00.

This volume is the first major work on the birds of Costa Rica since Carriker's "List of the Birds of Costa Rica" (*Ann. Carnegie Mus.*, 6:314–915), published in 1910. Though the country is small (slightly larger than San Bernardino County, California, and slightly smaller than West Virginia), it has a coastline on both the Pacific Ocean and the Caribbean Sea, elevations in excess of 12,000 feet, and regions receiving over 200 inches of rainfall annually. Even in view of favorable geography and topography, its list of 758 species is impressive. Dr. Slud summarizes distributional data on an ecological basis, and adds much information on the activities of the birds gained through his personal contact with most species recorded in the country.

The work is not an annotated list of specimens collected in Costa Rica, although sizable collections have been assembled from that country; nor is it even oriented along the lines of conventional taxonomic reports, although the author utilized existing specimen collections in preparing it. Instead, emphasis is on ecological preferences of living birds, based on the author's 7 years of field studies (between 1950 and 1962) in all areas of the country.

Most of the eight-page introductory section consists of lists of birds: 79 species added to the total compiled by Carriker in 1910, over 50 species unrecorded but possible, and six species and an additional 32 races endemic to Costa Rica. On the basis of "geography, climate, and geological history," Slud divides the country into four main avifaunal zones: the northwestern Pacific slope or "Guanacaste" area (relatively dry), the southern portion of the Pacific slope and the Caribbean slope (both are regions of high rainfall and humidity), and the Costa Rica–Chiriquí highlands. Species characteristic of each zone are listed; the Guanacaste zone shares many species with Mexico and Central America, whereas the other zones have affinities with South America. Several pages are devoted to descriptions of the life zones present in Costa Rica. The life-zone concept utilized in this report follows the Holdridge scheme of classifying vegetation by temperature and precipitation.

Most (363 pages) of the book is devoted to the accounts of species. Each begins with the scientific name, the common English vernacular name, and range of the species. Then follow names and ranges of subspecies occurring at least partly in Costa Rica. Distribution is described on the basis of the life zones and avifaunal zones occupied by the species, and by the races if more than one is present. In order to determine distribution, Dr. Slud attempted to locate on a life-zone map of Costa Rica every locality at which a species had been observed or collected. He then considered these points of record in preparing the distributional descriptions. Usually only major physiographic features are used in this treatment; specific localities are mentioned only in the case of rarely recorded species. Frequently comment is made on areas presumed suitable but not occupied by the species. Then follow remarks on preferred habitats, activities, and vocalizations as derived in most cases entirely upon the personal observations of the author. A foldout life-zone map of Costa Rica (including all sites where birds have been observed or collected) and an index to localities on the map are provided. An

annotated list of locality names requiring explanation (including ones that the author could not find on any map) provides supplementary information. References and an index complete the work.

I am particularly impressed by the skill with which Dr. Slud has succeeded in describing birds' habitats and their routine activities. For many of the 620 breeding species, these descriptions are the only ones ever published. Observations of habitats and behavior of North American species occurring as transients or winter visitants in Costa Rica provide much information not available elsewhere. Considerable space is devoted to phonetic interpretations of vocalizations and comparisons of the similar calls and songs of different species. In reading the species accounts, I repeatedly felt that the author must have run out of space before completing them. This impression was my major disappointment with the book. It seemed to me that, following such vivid descriptions of daily actions and elaborate representations of songs and calls, something certainly should have been included on breeding biology. I cannot find a statement describing the duration of the nesting season, or mention of nests or young birds.

For anyone working with neotropical birds, English names have been and will continue to be a major problem. Recent authors are in agreement only to the extent that new common names are very rarely conceived. Dr. Slud does not state the policy he followed in selecting English names, but it is evident that he has employed names from a variety of sources, seemingly preferring to utilize patronyms after the practice of Ridgway, Cory, and Hellmayr. For example, of the 54 species of hummingbirds discussed by Slud, English names of 13 were used by both Eisenmann ("The Species of Middle American Birds") and Cory ("Catalogue of Birds of the Americas," Part 2, No. 1), 13 follow Eisenmann, 27 were used by Cory but not Eisenmann, and one is a Ridgway name utilized by neither Cory nor Eisenmann. Local Costa Rican names are infrequently mentioned in the accounts.

Although Dr. Slud has taken care to explain (p. 22) that his report viewed distribution from ecological aspects, considerable attention to systematics was nevertheless necessary. The reader cannot always determine to what extent Dr. Slud personally examined specimen collections in order to verify identifications. Only about five per cent of the species accounts contain references to specific specimens in named collections. Presumably many specimens collected by Carriker are in the Carnegie Museum, yet none is cited in this work. A statement summarizing the present locations of the major collections of birds from Costa Rica and the extent to which Slud actually examined these collections would have answered many questions. The reader is referred to Carriker (loc. cit.) for a résumé of collecting activities up to 1910, but Charles H. Lankester, Austin Paul Smith, and Slud are the only collectors mentioned as following Carriker. Their collecting activities are not detailed. The treatment of many taxonomic questions is perfectly adequate, but not in all cases. For example, it is not good practice to speculate on subspecific identities on the basis of birds seen in the field but not collected (as Slud did with *Laterallus ruber*).

Dr. Slud mentions (p. 23) that many more species of birds than are generally realized undergo seasonal altitudinal migration. Further discussion of this topic would have been worthwhile; only by reading all species accounts is it possible to find out which birds are involved and to what extent.

"Birds of Costa Rica" is relatively free of inconsistencies and typographical errors. Brackets are used around accounts of species not substantiated by a specimen or other tangible evidence, but the Western Kingbird and Parula Warbler are not enclosed, whereas the Cave Swallow is within brackets; each is represented by a specimen collected

by Austin Smith that Slud was unable to find. Terms expressing relative abundance (such as numerous, common, rare, etc.) are used throughout the report but are not defined. The work does not contain the intriguing considerations of historical and zoogeographical problems that were in the author's "Birds of Finca 'La Selva'" (*Bull. Amer. Mus. Nat. Hist.*, 121:49–148, 1960). Although a "dry season" is characteristic of many areas in Costa Rica, the months involved are not listed.

Individuals working with neotropical species will find this report on Costa Rican birds indispensable. Systematists may wish for more details on taxonomy and ethologists may desire more data on behavior, but everyone who uses it will appreciate its wealth of information.—Stephen M. Russell.

ANNUAL REPORT OF THE CONSERVATION COMMITTEE

The period between the 1964 and 1965 meetings of the Wilson Ornithological Society will prove of special interest to historians of conservation as the year in which the U.S. Fish & Wildlife Service got back into wildlife conservation in earnest, in contradistinction to the game management emphasis that has preoccupied it in recent decades.

Conservationists everywhere applauded the appointment of John S. Gottschalk, a former fisheries biologist, as director of the Bureau of Sports Fisheries and Wildlife within the Service; and they backed H.R. 9424 and H.R. 9493, identical pieces of legislation "to provide for the conservation, protection, and propagation of native species of fish and wildlife, including migratory birds, that are threatened with extinction. . . ." Senator Karl Mundt proposed an amendment to the Department of Interior appropriations bill for fiscal year 1966 that would provide extra funds to establish a research program and center to implement these same objectives. The provisions of the recently approved Land and Water Conservation Fund Act may soon provide additional funds, collected as entrance fees on federal refuges and parks, that may, in part, be used for land acquisition on behalf of threatened species.

The Bureau of Sports Fisheries and Wildlife published an attractive booklet, "Survival Or Surrender for Endangered Wildlife" (available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., for $0.15), that makes an eloquent plea for a concerted national effort on behalf of 78 endangered species, including giving closer attention to the status of 44 additional rare forms, and 21 whose occurrence within the United States is peripheral to the principal range of their species.

The booklet gives thumbnail sketches of a mere 15 of these endangered species, but the complete list has been published in a "Red Book" distributed to a limited group of conservationists and zoologists for comment.

It is the consensus of this committee that the full list deserves wider, if controlled, distribution. The present list is understandably provisional in character, since our knowledge of the status and needs of most species is still highly fragmentary. It must continue to remain "fluid" because man's activities in influencing wildlife, directly or indirectly, are subject to continuing change.

It is true that—given the relatively low level of biological understanding that still characterizes American society as a whole, and the nature of so much of America's politics, where ridicule is often substituted for discussion—there are dangers in distributing such a list too widely. The inclusion of species like the humpback chub or the Block Island meadow vole, if only provisionally or as a matter of scientific consistency, is sure to invite derision from certain elements.

Nevertheless, the setting of priorities and the development of a conservation program must have a starting point, and the way to round out our meager understanding of the status and requirements of various species is to begin with a list. Land acquisition will actually be only a part of this big task of ensuring the perpetuation of these rare forms. Circulation of the list to a wider circle of competent university zoologists will help call attention to the extensive field research opportunities inherent in rounding out the list, and in collecting the life history and ecological data that alone can form the basis for sound management. Such a list will also allow us to enroll the cooperation of the scores of land-use agencies whose programs affect the survival of *all* wildlife. The engineers who are remaking the American landscape, and indeed the landscapes of the world, do not know these requirements. It is up to the naturalist to supply them in advance, so that they may be incorporated in engineering design.

The Bureau's plans place a commendable emphasis on field research in this new program, and will, in addition, involve considerable experimentation with the potentialities of captive propagation methods to reinforce wild populations. There is growing awareness that all approaches must be explored, but, also, a counterbalancing insistence that action programs must not outrun understanding.

Several students (e.g., Allen, 1965; Clement, 1964) are convinced that illegal shooting remains a serious limiting factor for many large bird species. It is therefore important that we all insist on more effective protective laws and a much greater enforcement effort, lest even this new federal program be rendered ineffective by failures of enforcement. There is great cultural lag here, since failures of enforcement are, in many cases, failures of the judiciary to back State and Federal enforcement agencies.

ENDANGERED SPECIES

Though its Florida population seems still healthy, an air–land survey of the entire Texas–Louisiana coast by A. S. Sprunt, IV in June 1965, revealed that the *Brown Pelican* failed to produce young on that coast this year, and that only three or four pairs attempted to nest at all. Disturbance by an oil-drilling operation may have been responsible for the failure of the Second-Chain of Islands Sanctuary colony this spring. The 1966 nesting season will show whether or not this is the end of a decade-long decline for this species on the western Gulf Coast. There are no more than about 30 birds on the Texas coast at present.

A 2-year field study of the status of the *California Condor* (Miller, McMillan, and McMillan, 1965) reports a 30 per cent decline in the population of this species—from about 60 to only about 40 individual birds—since Karl Koford first detailed the status and life history of this ancient bird in 1953. The decimating factors held responsible for this decline were the gun, government poisoning programs, and disturbance of nesting and roosting areas. As a result of these disturbing revelations, the U.S. Forest Service—in whose domain all remaining California Condors nest—the California Fish and Game Department, and the National Audubon Society have joined forces to weld a more effective education and law enforcement program on behalf of the condor and other large raptors in southern California.

The U.S. Fish and Wildlife Service will help extend the research work already done. All these agencies will soon have to pass on the biological feasibility of building a road across the condor refuge in the Los Padres National Forest and developing a water reservoir on its northern border, insofar as effects on the condor are concerned. These two work projects have been proposed by the local United Water Conservation District, but the Condor Advisory Committee, which advises the Forest Service, has already expressed itself against the project, and public opinion, it is hoped, will soon force recourse to alternative sources of water for the area. As Carl W. Buchheister wrote of the condor (*in* Miller et al. 1965), "All it needs is elbow room and to be left alone. What space we leave or fail to leave for it will be a measure of the level of our civilization."

Thirty-two collaborators in the *Bald Eagle* Research and Conservation Program of the National Audubon Society gathered at the Winous Point Shooting Club near Port Clinton, Ohio, 29–31 May 1965, to review their understanding of eagle biology and focus attention on the many unanswered questions in this species' future. Most intriguing was a report from David Hancock of the University of British Columbia that his field studies suggested a delayed effect of disturbance among nesting eagles. A further check of this phenomenon is under way.

Whooping Crane.—Eleven young wild birds were produced in 1964, the best produc-

tion year on record. One of these young was injured on the nesting grounds, however, and subsequently rescued (Novakowski, 1965). With 42 birds on the wintering grounds, this crane may have surpassed the condor in abundance.

Eskimo Curlew.—On 4 September 1964 a gunner in Barbados—the easternmost of the Lesser Antillean islands, and thus the interceptor of the long over-water flights of shorebirds which come down from maritime Canada in autumn—killed a bird which, fortunately, was eyed as different enough to be submitted to professional examination. The specimen was shipped to Dr. James Bond of the Philadelphia Academy of Sciences and there identified as *Numenius borealis.* It is the first specimen record since 1932, when a bird taken in Newfoundland Labrador was preserved. Barbados has always been a notorious shorebird gauntlet; this incident points up the importance of better laws and adequate enforcement.

ANIMAL CONTROL

Two bills, H.R. 4159 and S. 1952, were introduced in the Congress to attempt to reorganize the federal predator control program, making it a research and advisory, or "extension," service instead of an end in itself. The Bureau of Sports Fisheries and Wildlife attempted to clean its own house by changing the name of its Branch from Predator and Rodent Control to a Wildlife Services Division, and by appointing a thoroughly competent wildlife professional to head it. Immediately, however, pressures from western stockmen made it questionable that a scientific approach to reorganization would suffice.

(During discussion at the Black Hills meeting, R. C. Clement warned of a quiet move on the part of the agricultural community to bring the U.S. Department of Agriculture into the blackbird control program, even though the Department of the Interior is already charged with responsibility in this field, and doing active research and experimental control work. "The pattern," he said, "is that typical of all ambitious bureaucracies: convince the farmer he has a big problem, even though complaints were heretofore local and occasional only—to do this, lump everybody's losses from problem animals; beat the drums for more funds to solve the newly created problem; and get your friends to introduce and pass legislation declaring the organisms pests that shall be eradicated."

(Commenting on the socioeconomic background of this problem, it was suggested that the success of the federally supported land grant college approach has so increased production and narrowed profits by increasing costs that both the agricultural bureaucrat and the farmer are in trouble. The declining number of farms require fewer government advisors, and the farmer can less and less afford the tithe of his production that has always, heretofore, gone to his natural competitors, the insects and the wild vertebrates.

(As was pointed out, the objective of these comments is not mere criticism of the Department of Agriculture, but an attempt to understand what is happening. A bureaucracy faced with obsolescence does what industry does—it diversifies. Staff jobs must be maintained. This being so, we had better work out a plan to support people for conserving all our nation's natural resources, rather than subsidizing their destruction, as is so largely the case today.)

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WOS Conservation Committee
Roland C. Clement, Chairman
John W. Aldrich
Clarence Cottam
Alexander Sprunt, IV

PROCEEDINGS OF THE FORTY-SIXTH ANNUAL MEETING

PERSHING B. HOFSLUND, SECRETARY

The Forty-Sixth Annual Meeting of the Wilson Ornithologieal Soeiety was held Thursday, 17 June to Sunday, 20 June 1965 at the Sylvan Lake Resort, Custer, South Dakota. The meeting was sponsored by the Blaek Hills Audubon Soeiety and the South Dakota Ornithologists' Union, the local committee being under the ehairmanship of Dr. Nathaniel R. Whitney, Jr. The meeting was attended by 212 registered members and guests.

The meeting opened with an informal reeeption at the Lodge, featuring museum skins of the birds of the Blaek Hills. On Friday morning, the first of four papers sessions was opened with a welcome given by Dr. Whitney and a response from Wilson Soeiety President, Roger Tory Peterson. On Friday evening Dr. O. S. Pettingill, Jr., showed his film on the Blaek Hills, "In the Hills of Gold." The annual dinner, held in the Lodge Dining Room on Saturday night was buffet style with buffalo roast as the pièee de resistánee. The program following the dinner, emeeed by Dr. O. S. Pettingill, Jr., featured the presidential address by Roger Tory Peterson and a talk by Herbert Krause on the "History of the Northern Great Plains with Speeial Referenee to Ornithology." The guests were presented with souvenir plates of the meeting bearing the motif of White-winged Juneos.

There were early morning trips in the vieinity of Sylvan Lake and on Sunday an all-day field trip to Spearfish Canyon. Perhaps the star attraetions on this field trip were a Dusky Flyeateher whieh obligingly remained on its nest for the photographers and a Dipper that bathed uneoneernedly in the baekwash of the river so that all members present could have an exeellent view of it.

This was one of the espeeially memorable meetings and eredit must go to the planning and hard work of the loeal eommittee, plus the weatherman, who after an inauspieious start on the first evening provided 3 days of almost perfeet weather for the rest of the meeting.

FIRST BUSINESS SESSION

President Peterson ealled the meeting to order at 10:00 AM, Friday, 18 June. Following Dr. Whitney's welcome and President Peterson's response, the business session was opened with the approval of the Proeeedings of the Forty-fifth Annual Meeting as published in *The Wilson Bulletin* for September 1964.

Secretary's Report

The Secretary, Pershing B. Hofslund, summarized the prineipal aetions taken at the Thursday evening meeting of the Exeeutive Counеil as follows:

1. The Counеil reaffirmed the invitation from Pennsylvania State University to hold the 47th annual meeting on the Pennsylvania State University eampus, University Park, Pennsylvania from 27 April to 1 May 1966.
2. The Counеil reeeived a tentative invitation from the New Hampshire Audubon Soeiety to hold the 1967 meeting in New Hampshire. Site and dates were uneertain, so the Seeretary was instructed to eorrespond further with members of the inviting group, and also with Southern Illinois University which had indicated some interest in hosting a meeting.
3. George A. Hall was re-eleeted editor of *The Wilson Bulletin*.
4. The Counеil noted with sorrow the passing of the last founder of the Society, Rueben M. Strong.

5. The Council voted to accept the report of the Research Committee and award the 1965 Louis Agassiz Fuertes Grant to John O. Sullivan, Department of Zoology, Montana State University, Missoula, Montana for work on the "Ecology of the Dipper, *Cinclus mexicanus*."
6. The Council voted to continue support of the International Council for Bird Protection.
7. The Council voted not to continue affiliation with the American Association for the Advancement of Science.
8. All committee and officer reports were accepted by the Council.

Treasurer's Report

Report of The Treasurer for 1964

General Fund

Balance as shown by last report dated 31 December 1963		$ 3,770.99
RECEIPTS		
Dues		
Active Memberships	$6,937.00	
Sustaining Memberships	760.00	$ 7,697.00
Subscriptions to *The Wilson Bulletin*		1,495.00
Sales of back issues of *The Wilson Bulletin*		262.88
Interest and Dividends on savings and investments		1,313.99
Gifts		1,338.25
Royalties from microfilming back issues of *The Wilson Bulletin*		7.70
Total Receipts		$12,114.82
DISBURSEMENTS		
The Wilson Bulletin (printing and engraving)		$ 8,174.51
The Wilson Bulletin (mailing and maintenance of list)		1,322.66
Editor's expense		151.20
Secretary's expense		61.45
Treasurer's expense		456.37
Canadian discount on checks and money		19.47
Annual Meeting expense		293.67
Committee expense		116.05
International Council for Bird Protection (1964 dues)		25.00
Total Disbursements		$10,620.38
Excess of Receipts over Expenses for year 1964		$ 1,494.44
Balance on hand in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1964		$ 5,265.43

Josselyn Van Tyne Memorial Library Book Fund

Balance as shown by last report dated 31 December 1963		$ 665.71
RECEIPTS		
Sale of duplicates and gifts	$ 142.35	

DISBURSEMENTS

Purchase of books and postage	325.28	$ 182.93
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1964		$ 482.78

LOUIS AGASSIZ FUERTES RESEARCH FUND

Balance as shown by last report dated 31 December 1963		$ 100.00
RECEIPTS		
Contributions		36.00
Total		$ 136.00
DISBURSEMENTS		
Award to Robert E. Gobeil		$ 100.00
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1964		$ 36.00

ENDOWMENT FUND

Balance in Savings Account as shown by last report dated 31 December 1963		$ 265.66
RECEIPTS		
Life Membership payments	$ 2,800.00	
Patronship payments	3,975.00	$ 6,775.00
Stock dividends received (included below)		
8 shares Massachusetts Investors Trust		
Total		$ 7,040.66
DISBURSEMENTS		
Purchase of 75 shares Phillips Petroleum		$ 3,710.38
Balance in Savings Account, Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1964		$ 3,330.28

SECURITIES OWNED (listed at closing prices 31 December 1964)

$5,000 U.S. Treasury 4% Bonds due 1 October 1969 at 99 17/32	$ 4,976.56	
$5,000 U.S. Treasury 4% Bonds due 15 August 1972 at 98 23/32	4,935.94	
$5,000 Bankers Trust Co. 4½% Capital Notes due 15 December 1988 at 101	5,050.00	
$3,000 Phillips Petroleum Co. 4½% cvt. Bonds due 15 February 1987 at 118½	3,555.00	
15 shares Kaiser Aluminum & Chemical 4¾% cum. cvt. pfd. (1957 Series) at 101½	1,522.50	
25 shares Owens-Illinois Glass Co. 4% cum. pfd. at 97⅝	2,440.63	
70 shares M. A. Hanna Co. at 38⅛	2,668.75	
210 shares Fireman's Fund Insurance at 38	7,980.00	
424 shares Massachusetts Investors Trust at 17.19	7,288.56	
75 shares Phillips Petroleum Co. at 53½	4,012.50	
Total Securities Owned		$44,430.44
Total Endowment Fund, 31 December 1964		$47,760.72

Respectfully submitted,
C. CHANDLER ROSS
Treasurer

Research Grant Committee

In the absence of Harrison Tordoff, Chairman of the Louis Agassiz Fuertes Researeh Grant Committee, the Secretary summarized the eommittee's report.

Notice of the grant competition was published in major ornithologieal journals well in advance of the March 1 deadline for application. Many inquiries were reccived, and eleven completed applications resulted.

These eleven applications were a strong lot. The Committee was pleased to have a good slate to choose from, although it is unfortunate that we ean support only one. It would be a mistake, they believc, to divide the already modest award of $100 among two or more applieants.

After consideration of sevcral factors the committee reeommendcd John O. Sullivan's application for the award provided it was the Council's belief that the intent of thc award was for American research.

Conservation Committee Report

Roland Clement, Chairman of the Conservation Committee, summarized thc report for the attending audience. A eomplete report appears elsewhere in this issue of the *Bulletin*.

Membership Committee Report

Chairwoman Hazel Bradley Lory reports that this eommittee has funetioned with 16 members this year. A few members who could serve no longer were dropped and four new ones added, two in the Southeast, one in the Midwest, and one in the northwestern part of the U.S. This distribution was an attempt to cover more thoroughly some areas where our membership is small.

The committec has on file an application card for each of 153 new members, whieh is 23 more than last year. Of this number 51 were secured by the members of our committee. Twenty-five other membcrs of the Socicty were instrumental in securing another 39 members.

It is heartening to notc that of the 153 new members, about one-fourth (39) are students, many of them doing graduatc work. With sueh an annual increase of young intellectuals, we need not worry about the quality of our Soeiety in the future.

Library Committee Report

The Secretary read the following report from William Lunk, Chairman of the Library Committee:

The past year was another satisfactory but unevcntful one for the Library Committee. It saw a continued increasc in our holdings and in our normal aetivities; the usual number of routinc decisions wcrc made, and appropriate action taken, by the Ann Arbor members of thc committee.

The new and enlarged storage facilities for the Josselyn Van Tync Memorial Library, rcsulting from the gencral expansion of the Bird Division, Museum of Zoology, arc working out very satisfaetorily, and to everyone's advantage.

Constant use is being madc of the library loeally, both by loeal members and enthusiasts and by out-of-town visitors. Sixty-three out-of-town loans went to 50 individuals during the year, a total of 174 items.

Sixty-four gifts were rceeived, from 46 individuals, total aequisitions being 176 books, 205 journals, 315 reprints, 66 pamphlets, and 17 translations.

Again worthy of particular mention was another inerement, 54 books on gencral

ornithological subjects and 51 journal volumes, of the late Josselyn Van Tyne's large personal library, accepted as a gift from Mrs. Van Tyne.

We are receiving about 115 current journals, 88 of them by exchange—both of these figures representing increases over last year.

Continued use is made of the New Book Fund, for purchase of needed works and for special items such as occasional bindery fees. Member support is excellent, but can always be improved. Cash donations to the fund are solicited, as are gifts of items which the library can use directly or hold for eventual resale. Members are also urged to borrow from our outstanding collection as the need arises.

Special thanks are due, as always, to Norman Ford, of the Bird Division, a great deal of whose time is spent in the efficient handling of all administrative details for the library.

Endowment Committee Report

The Secretary reported a communication from Chairman Stephen Eaton that no action had been taken by this committee during the past year.

Temporary Committees

President Peterson appointed the following temporary committees:

Auditing Committee
Edward L. Altemus
John H. Foster
Alan Crawford, Jr., Chairman

Nominating Committee
Burt Monroe, Sr.
George M. Sutton
O. S. Pettingill, Jr., Chairman

Resolutions Committee
Willetta Lueshen
Harold Mayfield
Maurice Brooks, Chairman

SECOND BUSINESS SESSION

The final business session was called to order at 3:00 PM, Saturday, 19 June.

Report of the Auditing Committee

The president read the report of the Auditing Committee which in its opinion represented fairly the financial condition of the Society. It commended the treasurer for his precise and detailed accounting.

Report of the Resolutions Committee

Chairman Brooks gave the following resolutions:

BE IT RESOLVED, that the Wilson Ornithological Society express to the Black Hills Audubon Society and to the South Dakota Ornithologists' Union its profound appreciation for their serving so efficiently as our hosts for the forty-sixth annual meeting.

We wish to thank especially the local committee under its chairman for work under difficult conditions.

BE IT FURTHER RESOLVED that in a time of increased commercialism the W.O.S. is profoundly grateful to its past and present officers, committee chairmen, and committee members for willing and unselfish service in the true amateur spirit. The Society, even in its present healthy condition, could not pay for such devoted service.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, Roger Tory Peterson; First Vice-President, Aaron M. Bagg; Second Vice-President, H. Lewis Batts, Jr.; Secretary, Pershing B. Hofslund; Treasurer, C. Chandler Ross; Elective Member to the Council, Jeff Swinebroad (term to expire in 1968).

The report of the Nominating Committee being accepted, and there being no nominations from the floor, the Secretary was instructed to cast a unanimous ballot for these nominees.

PAPERS SESSIONS

Friday, 18 June

1. Nelda and David J. Holden, Brookings, South Dakota. *Birds and the Changing Prairies.*
2. Nathaniel R. Whitney, Jr., Rapid City, South Dakota. *A Life History Study of the White-winged Junco.*
3. Edwin O. Willis, American Museum of Natural History. *Social Organization in Plain-brown Woodcreepers.*
4. Daniel D. Berger, Cedar Grove Ornithological Station. *Some Observations Concerning the Molt of Saw-whet Owls.*
5. S. Charles Kendeigh, University of Illinois. *Bioenergetics and Bird Activities.*
6. J. Dan Webster, Hanover College. *An Analysis of Winter Bird Population Studies.*
7. Ronald A. Ryder, Colorado State University. *Some Results from Color Marking Gulls in Colorado.*
8. Thomas L. Morrow and Fred A. Glover, Colorado Cooperative Wildlife Research Unit, Colorado State University. *Estimating Time of Death in Mallards.*
9. Bertin W. Anderson, University of Minnesota. *A Morphological Analysis of a Large Sample of Lesser Scaup* (Aythya affinis) *and Ring-necked Ducks* (A. collaris).
10. Dean Amadon, American Museum of Natural History. *Comments on Proposed Reforms in Scientific Names.*
11. Herbert Krause, Augustana College. *The Range of McCown's Longspur as Seen in the Literature.*
12. Richard C. Banks, San Diego Natural History Museum. *Age and Sex Determination in the Hummingbird Genus* Archilochus.
13. Mrs. Charles Hartshorne, Austin, Texas. *An Endangered Species—the Golden-cheeked Warbler.*

Saturday, 19 June

14. James L. Baillie, Royal Ontario Museum, Toronto. *Ontario's Most Recent Birds.*
15. Helmut C. Mueller, University of Wisconsin. *The Autumn Migration of Sharp-shinned Hawks at Cedar Grove, Wisconsin.*
16. Jeff Swinebroad, Rutgers University, and Raymond E. Kerlin and William C. Carter, Bureau of Veterinary Public Health, Trenton, New Jersey. *Stop-over and Local Movements of Migrating Gray-cheeked Thrushes* (Hylocichla minima).
17. Harold Mayfield, Toledo, Ohio. *Loss of Ability to Hear High-pitched Bird Songs with Advancing Age.*
18. Charles Hartshorne, University of Texas. *Song Development in the Wood Warblers.*
19. R. Bruce Gill and Fred A. Glover, Colorado Cooperative Wildlife Research Unit, Colorado State University. *Daily and Seasonal Movements of Sage Grouse.*
20. Lewis W. Oring, Oklahoma University. *Shorebird Migration at Norman, Oklahoma: 1961–1963.*

21. Robert Storer, University of Michigan. *Courtship Behavior of the Western Grebe.*
22. Paul A. Johnsgard, University of Nebraska. *The Displays of the Australian Musk Duck* (Biziura lobata).
23. George M. Sutton, University of Oklahoma and David Parmalee, Kansas State Teachers College, Emporia. *An Ornithological Summer on Victoria Island.*
24. G. Stuart Keith, American Museum of Natural History. *Sound Recordings of the Yellow Rail in Minnesota.*

ATTENDANCE

Members and guests who registered totaled 212 persons. Twenty-eight states, plus Washington, D.C. and Ontario, Canada, were represented.

From **Arizona**: 1—*Thatcher*, E. D. Bawdon.

From **California**: 2—*La Mesa*, Jean W. Cohn; *San Diego*, Richard D. Banks.

From **Colorado**: 9—*Aurora*, Lois Webster; *Boulder*, E. R. Kalmbach; *Denver*, Nancy A. Hurley, Donald M. Thatcher; *Evergreen*, Mr. and Mrs. D. A. Walich; *Fort Collins*, R. Bruce Gill, Mr. and Mrs. Ronald A. Ryder.

From **Connecticut**: 3—*Norwalk*, Roland C. Clement; *Old Lyme*, Dr. and Mrs. Roger Tory Peterson.

From **Florida**: 2—*Jacksonville*, Mrs. V. J. Obenauer, Jr.; *Tavernier*, Frank Ligas.

From **Illinois**: 6—*Champaign*, Dr. and Mrs. S. Charles Kendeigh; *Decatur*, Mr. and Mrs. C. Turner Nearing; *Momence*, Mr. and Mrs. William T. Lory.

From **Indiana**: 3—*Bloomington*, Jack Humbles; *Hanover*, Dr. and Mrs. J. Dan Webster.

From **Iowa**: 9—*Cedar Rapids*, Mrs. E. J. Patranek, Myra G. Willis; *Davenport*, Peter Peterson, Jr.; *Grinnell*, Helen T. Stewart, Mildred Stewart; *Iowa City*, Lee Eberly; *Lehigh*, Dean Roosa; *Sioux City*, Mr. and Mrs. Garland Roose.

From **Kansas**: 3—*Emporia*, Dale W. Greiner, Robert Neill; *Topeka*, Orville O. Riee.

From **Maryland**: 2—*Laurel*, Allen J. Duvall, Chandler S. Robbins.

From **Massachusetts**: 2—*Dover*, Mr. and Mrs. Aaron M. Bagg.

From **Michigan**: 5—*Ann Arbor*, Robert W. Storer; *Marquette*, Mrs. Mary Spear Ross; *Mount Pleasant*, Irene F. Jorae; *South Lyon*, Mrs. Alice D. Miller; *Traverse City*, Mrs. Howard Edwards.

From **Minnesota**: 21—*Crosby*, Mr. and Mrs. Steve Blanich; *Duluth*, Donald Davidson, Dr. and Mrs. P. B. Hofslund, Mr. and Mrs. Harvey Putnam; *Elk River*, C. E. Munns; *Minneapolis*, Bertin W. Anderson, Mr. and Mrs. Wendell Brown, Mrs. E. M. Drissen, S. Peter Getman, Mr. and Mrs. M. G. Goldberg, Mr. and Mrs. Vincent A. Heig, Eugene A. Le Febvre; *Moorhead*, Mrs. Leslie Wetter, Jr.; *South St. Paul*, Mr. and Mrs. Thomas C. Savage.

From **Nebraska**: 9—*Beatrice*, Kent Fiala; *Lincoln*, Paul A. Johnsgard; *Minatare*, Mrs. Nora Mae Vanee; *Scotts Bluff*, Mr. and Mrs. Harry A. Banghart, Mrs. Julia J. Brashear, Mr. and Mrs. Roy Witschy; *Wisner*, Mrs. John Lueshen.

From **New Hampshire**: 1—*New Hampton*, Robert W. Smart.

From **New Jersey**: 3—*New Brunswick*, Jeff Swinebroad; *Newfoundland*, Mr. and Mrs. Frank Townsend.

From **New York**: 7—*Buffalo*, Mr. and Mrs. Edward C. Ulrich; *Ithaca*, Dr. and Mrs. Olin Sewall Pettingill, Jr.; *New York City*, Dean Amadon, Edwin O. Willis; *Waterloo*, Jayson A. Walker.

From **North Dakota**: 2—*Kenmare*, Dr. and Mrs. R. T. Gammell.

From **Ohio**: 15—*Ashtabula*, Howard E. Blakeslee; *Canfield*, Dr. and Mrs. G. Wm. Richter; *Cincinnati*, Mrs. Nathaniel Whitney, Sr.; *Gambier*, Robert D. Burns; *Girard*,

Mr. and Mrs. H. O. Heimerdinger; *Lakewood*, Mr. and Mrs. William A. Klamm; *Tiffin*, Mr. and Mrs. A. G. McQuate; *Toledo*, John M. McCormick; *Waterville*, Harold F. Mayfield; *Youngstown*, Mr. and Mrs. William C. Baker.

From **Oklahoma**: 4—*Norman*, Mr. and Mrs. Lewis Oring, George M. Sutton; *Tulsa*, Mrs. Walter A. McKinney.

From **Pennsylvania**: 5—*Lansdowne*, Janet Gross; *Philadelphia*, C. Chandler Ross; *Pittsburgh*, Mary A. Heimerdinger, Dr. and Mrs. Kenneth C. Parkes.

From **South Dakota**: 56—*Aberdeen*, Mrs. Harry Cramer, Gertrude Miller, Mr. and Mrs. Jack K. Saunders; *Armour*, Mr. and Mrs. C. P. Crutchett; *Big Stone City*, Mr. and Mrs. Arthur H. Riss; *Britton*, Mrs. Herman E. Carlson, Mrs. Ella McNeil, Mrs. A. M. Odland; *Brookings*, Mr. and Mrs. Richard Edie, Mr. and Mrs. David J. Holden; *Deadwood*, Virgil Van Heuvelen; *Highmore*, Lois Harter, Mrs. Morris Harter; *Hot Springs*, Mrs. Andrew Gossel, Robert A. Gossel, Mr. and Mrs. C. J. Twomey; *Huron*, J. W. Johnson, Mr. and Mrs. George M. Jonkel; *Madison*, Ruth Habeger; *Pine Ridge*, Donald Swartz; *Provo*, Christine Hajek, Adelaide Ward; *Rapid City*, Gertrude Bachman, L. M. Baylor, Violet L. Brodsky, Mrs. Goldie Burton, Mr. and Mrs. Keith Evans, Mary Hyde, Mr. and Mrs. H. J. Jackson, Mark Jackson, Kay Martin, Mr. and Mrs. Grover O'Neal, Gertrude Parmelee, Esther Serr, Mrs. R. L. Speakman, N. R. Whitney, Jr., Susan Whitney; *Sioux Falls*, Mr. and Mrs. Scott Finley, Herbert Krause, Glenn A. P. Peterson; *Vermillion*, Dr. and Mrs. Byron Harrell, Bill Huntley; *Watertown*, L. J. Moriarty; *Webster*, Mr. and Mrs. Herman Chilson.

From **Texas**: 4—*Austin*, Dr. and Mrs. Charles Hartshorne; *Friona*, Carroll Littlefield; *San Antonio*, Charles R. Bender.

From **Utah**: 2—*Dugway*, Thomas J. Lewis, Jr.; *Provo*, Herbert H. Frost.

From **Virginia**: 4—*Arlington*, Mr. and Mrs. Lawrence M. Bartlett, *Sweet Briar*, Dr. and Mrs. Ernest P. Edwards.

From **West Virginia**: 5—*Morgantown*, Mr. and Mrs. Maurice Brooks, Dr. and Mrs. George A. Hall, Earl N. McCue.

From **Wisconsin**: 6—*Green Bay*, Bill Talen; *Horicon*, Laurence R. Jahn; *Madison*, Dr. and Mrs. H. C. Mueller; *Milwaukee*, Daniel D. Berger; *Viroqua*, Margarette E. Morse.

From **Wyoming**: 2—*Newcastle*, Mrs. George Butler, Mrs. Willis M. Franz.

From **Washington, D.C.**: 1—Lester L. Short, Jr.

From **Ontario, Canada**: 8—*Clarkson*, Dr. and Mrs. William W. H. Gunn; *Fort William*, Dr. and Mrs. A. E. Allin; *Peterborough*, Doug Sadler; *Toronto*, Jim Baillie, Ralph McCleary, Russ Robson.

This issue of *The Wilson Bulletin* was published on 30 September 1965.

Editor of The Wilson Bulletin

GEORGE A. HALL

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West Virginia University
Morgantown, West Virginia

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Suggestions to Authors

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subsequently identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on gloss paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A Word to Members

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the printer of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated in the mailing list and there is a printer's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

Notice of Change of Address

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadephia 3, Pennsylvania. He will notify the printer.

Plan now to participate in

THE FORTY-SEVENTH ANNUAL MEETING

to be held at

PENNSYLVANIA STATE UNIVERSITY

UNIVERSITY PARK, PENNSYLVANIA

27 April–1 May 1966

The Wilson Bulletin

PUBLISHED BY THE WILSON ORNITHOLOGICAL SOCIETY
WEST VIRGINIA U. · MORGANTOWN, W. VA.

VOL. 77, No. 4, DECEMBER 1965 PAGES 325–431

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THE WILSON ORNITHOLOGICAL SOCIETY

FOUNDED DECEMBER 3, 1888

Named after ALEXANDER WILSON, the first American Ornithologist.

President—Roger Tory Peterson, Neck Road, Old Lyme, Connecticut.

First Vice-President—Aaron M. Bagg, Farm Street, Dover, Massachusetts.

Second Vice-President—H. Lewis Batts, Jr., Dept. of Biology, Kalamazoo College, Kalamazoo, Michigan.

Treasurer—C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadelphia 3, Pennsylvania.

Secretary—Pershing B. Hofslund, Dept. of Biology, Duluth Branch, University of Minnesota, Duluth, Minnesota.

Elected Council Members—Harvey I. Fisher (term expires 1966); William W. H. Gunn (term expires 1967); Jeff Swinebroad (term expires 1968).

Membership dues per calendar year are: Sustaining, $10.00; Active, $5.00.

THE WILSON BULLETIN is sent to all members not in arrears for dues.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

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THE WILSON BULLETIN

The official organ of the Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Morgantown, West Virginia. The subscription price, both in the United States and elsewhere, is $5.00 per year, effective in 1965. Single copies, $1.25. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at $1.25 each) and may be ordered from the Treasurer. Special prices will be quoted for quantity orders.

All articles and communications for publications, books and publications for reviews should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

Second class postage paid at Lawrence, Kansas, U.S.A. Additional entry at Ann Arbor, Mich.

PRINTED IN U.S.A. Allen Press Inc., Lawrence, Kansas

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by the Wilson Ornithological Society

Vol. 77, No. 4 | December 1965 | Pages 325–431

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A BREEDING AND MIGRATION SURVEY OF THE PEREGRINE FALCON

JAMES H. ENDERSON

DURING the last 30 years the Peregrine Falcon (*Falco peregrinus*) has been subjected to increasing interference by an expanding human population. Ratcliffe (1962) pointed out that Peregrines in Great Britain, after surviving direct persecution during World War II, have since 1950 shown an inexplicable severe drop in nesting success. The role of pesticides in the reduction of Peregrines in Great Britain was described by Cramp (1963), and other decimating factors by Ferguson-Lees (1963). While the species once bred widely in eastern United States (Hickey, 1942), D. Berger (unpublished data) found that they have become extinct in that region and are much reduced in the upper midwest region. Bond (1946) surveyed the breeding population of Peregrines in western North America and was optimistic about its future there.

In North America two important aspects concerning distribution and movements of this species have been largely overlooked by ornithologists. First, only occasional notes appear in the literature concerning the nesting of Peregrines in the Rocky Mountains from Colorado to Alberta. Second, their conspicuous fall migration on the shore of the Gulf of Mexico has not been studied. In this study, I attempted to determine the status of the Peregrine in the central Rocky Mountain region and to describe its migration on the Gulf Coast.

BREEDING STATUS

Methods.—A search of the literature and inquiries addressed to persons in the Rocky Mountain area yielded a list of suspected or known former nesting sites of Peregrines from southern Colorado to central Alberta, mostly east of the Continental Divide. I visited as many of these sites as possible between 27 April and 9 July 1964, traveling 8,756 miles by auto, 689 miles by boat, and 185 miles by light plane. Since Peregrines often nest in the vicinity of rivers, I traveled several major streams that flow eastward from the mountains and checked all cliffs found. Sometimes I fired a rifle at the cliff to flush any hidden falcon. All cliffs were routinely examined with binoculars or a 20× telescope and special attention was paid to those marked with excrement. In this paper, I purposely have not disclosed exact nesting localities.

Colorado.—In Colorado I traveled 1,550 miles by auto, visiting 12 of 18 known former nesting sites, and of the remaining 6, 3 were visited by other workers. Six of the 15 visited sites were occupied by pairs of Peregrines,

while one had a single falcon. Of the eight unoccupied sites, five were used at least until 1960, and another has evidently not been used since 1884. Two others were abandoned in the early 1950's. Below is a summary of nesting sites in Colorado.

1. El Paso County—occupied since 1947 (Knorr, 1959); occupied 1963, 1964.
2. El Paso County—occupied 1950, used by other species in later years (R. Stabler, pers. comm.); unoccupied 1963, 1964.
3. El Paso County—occupied 1884 (two specimens by Aiken, in Univ. of Colorado Museum); unoccupied in recent years.
4. Boulder County—occupied 1950 (French, 1951); occupied 1958 (banding record); unoccupied after 1960.
5. Jefferson County—occupied 1962, 1963; one adult present 1964.
6. Fremont County—occupied 1963, 1964.
7. Montrose County—occupied 1937 (Grater, 1937); occupied 1964.
8. Larimer County—occupied 1937 (Gregg, 1938); occupied 1959, 1960 (T. Ray, pers. comm.).
9. Archulcta County—occupied 1946 (Niedrach, 1946); occupied 1959 or 1960, and 1963, 1964.
10. La Plata County—occupied 1962 (T. Ray, pers. comm.).
11. Montezuma County—occupied 1963; unoccupied 1964.
12. Moffat County—occupied 1957; 1962, 1963 (C. White, pers. comm.).
13. Park County—occupied 1953 (D. Galvin, pers. comm.); unoccupied 1963, 1964.
14. Mesa County—adults seen 1963, occupied 1964 (J. Stoddart, pers. comm.).
15. Garfield County—occupied about 1960 (T. Ray, pers. comm.); unoccupied 1964.
16. Conejos County—birds seen about 1960 (H. Webster, pers. comm.); unoccupied 1964.
17. Douglas County—occupied 1960 (T. Ray, pers. comm.).
18. Douglas County—occupied 1962 (D. Galvin, pers. comm.); unoccupied 1964.

Eight of the 15 visited sites were on cliffs more than 70 meters high on the tops and sides of mountains. Five were on lower cliffs, usually in the vicinity of a river, and two sites were in canyons whose vertical walls were over 300 m high.

Since most of the sites were visited only once, data on prey and nesting success are scanty. A Peregrine at one of the canyon sites was seen feeding on a Mourning Dove (*Zenaidura macroura*).

Only five young are known to have fledged from the six occupied sites in 1964, but there may have been three or four more.

Wyoming.—During fieldwork on the Prairie Falcon (*Falco mexicanus*) in Wyoming from 1959 to 1962, I did not encounter nesting Peregrines. Hence in this study I visited only a few likely places and three known former nest-sites in this state. No Peregrines were found in the deep canyon of the North Platte River between Pathfinder and Seminoe Reservoirs. Similarly I saw none in the deep Wind River Canyon south of Thermopolis, Wyoming. A former site in Jackson Hole, Teton County, active in 1958 (W. Higby and

R. Ballou, pers. comm.) has not been occupied since. Another locality in the same county where they had been seen was vacant. Peregrines nested in Yellowstone Canyon, Yellowstone National Park, in the 1950's (D. Beal, pers. comm.), but I could not find them there in 1961, 1962, or 1964. At another site in Yellowstone Park, active about 1960 (W. Fischer, pers. comm.) I saw an adult in 1964 and heard a second calling, but could not locate a nest.

Montana.—Between 2 and 10 June I visited 10 former nest-sites of Peregrines and floated 209 miles of the Yellowstone, Missouri, and Marias rivers in areas where they have been reported. I saw only a single adult. It roosted on a cliff that was used by Peregrines in 1911 (Saunders, 1911) and is now used by nesting Prairie Falcons. From the information on hand, it is impossible to determine when these sites were abandoned. Below is a summary of the history of the sites.

1. Gallatin County—occupied 1959 (C. White, pers. comm.); unoccupied 1964.
2. Gallatin County—occupied 1911 (Saunders, 1911); single adult 1964.
3. Park County—occupied 1959 (C. White, pers. comm.); apparently unoccupied 1964.
4. Park County—occupied 1963 (ibid.).
5. Sweet Grass County—occupied to 1956, lone adult 1957 (R. Elgas, pers. comm.); unoccupied 1964.
6. Stillwater County—occupied about 1940 (ibid.); unoccupied 1964.
7. Stillwater County—occupied about 1940 (ibid.); unoccupied 1964.
8. Cascade County—occupied early 1940's (R. L. Meredith, pers. comm.); unoccupied 1964.
9. Cascade County—occupied early 1940's (ibid.); unoccupied 1964.
10. Chouteau County—occupied about 1950 (ibid.); unoccupied 1964.

I did not visit three other Montana sites active in 1954 and 1955, 1962, and 1963, respectively, (J. Craighead, pers. comm.), or three others in Blaine County from which specimens were taken in the early 1900's (AMNH coll.). I also did not look for an old site in Prairie County (Cameron, 1907).

Alberta.—In Alberta I floated 478 miles of the Bow, Red Deer, North Saskatchewan, Pembina, McCleod, and Rosebud Rivers, and flew at low level 185 miles of the Athabasca River. Between 11 June and 3 July 1964 I visited 17 of 21 nesting sites, and another worker visited 2. Many more apparently suitable cliffs were observed. Six of these 19 sites were occupied by pairs, while an unmated adult male was found at one and a lone adult female at another. Of the 11 unoccupied sites, six were used at least as late as 1959. The following are the data on the Alberta sites.

1. Bow River—active 1962, male found dead (T. Ray, pers. comm.); female present 1964.
2. Old Man River—occupied 1959, unoccupied 1962 (ibid.).

3. Rosebud River—occupied 1933–37 (Salt, 1939); occupied 1957 (W. Salt, pers. comm.); unoccupied 1964.
4. Red Deer River—occupied in 1927–39 (ibid.); occupied in 1950's (ibid.); unoccupied 1964.
5. Red Deer River—occupied 1939 (ibid.); unoccupied 1964.
6. Red Deer River—occupied 1963 (W. McKay, pers. comm.); unoccupied 1964.
7. Red Deer River—occupied 1939 (K. Wood, pers. comm.); occupied 1963 (ibid.); occupied 1964.
8. Red Deer River—occupied 1919 (Taverner, 1919); apparently unoccupied 1964.
9. Sturgeon River—occupied 1960 (A. Oeming, pers. comm.); unoccupied 1964.
10. N. Saskatchewan River—occupied 1960 (ibid.); unoccupied 1964.
11. N. Saskatchewan River—occupied 1960 (ibid.); unoccupied 1964.
12. N. Saskatchewan River—history unknown; occupied 1964.
13. N. Saskatchewan River—history unknown; occupied 1964.
14. N. Saskatchewan River—occupied 1963 (W. McKay, pers. comm.); male present 1964.
15. N. Saskatchewan River—occupied 1962, 1963, 1964 (H. Dick, pers. comm.).
16. N. Saskatchewan River—occupied 1962, unoccupied 1963, occupied 1964 (ibid.).
17. Pembina River—history unknown; occupied 1964.
18. McCleod River—occupied 1930's (F. Beebe, pers. comm.); unoccupied 1964.
19. McCleod River—occupied 1930's (ibid.); unoccupied 1964.
20. Athabasca River—occupied in recent years (A. Oeming, pers. comm.); unoccupied 1964.
21. Calling River—history unknown; pair reported 1964.

The six occupied sites contained 14 young. Food remains found on or below the nesting ledges were a Starling (*Sturnus vulgaris*), a Robin (*Turdus migratorius*), a Mourning Dove, a Spotted Sandpiper (*Actitis macularia*), and Franklin's Gulls (*Larus pipixcan*). One nest had only numerous remains of Franklin's Gulls.

All of the nesting ledges were on dirt banks less than 13 m high and two of the active nests were on sheltered ledges on banks less than 4 m high.

MIGRATION

Methods.—From 10 to 14 October 1964, I counted, trapped, marked, and banded migrating Peregrines on a 36-mile section of beach on the Texas coast, and from 15 to 17 October I made additional studies on a similar 37-mile beach 30 miles farther north. I drove back and forth along the beaches throughout each day, counting falcons and attempting to catch all seen. In all, I drove 1,052 miles. During the count period weather was uniformly fair and warm, usually with moderate daytime onshore winds.

Observation of migrants.—On the south beach nine Peregrines were seen in 698 miles of travel, or one bird per 78 miles. Of these, five were trapped, marked, and banded. On the north beach I saw 43 Peregrines in 354 miles of travel, or one every 8 miles, and caught 10. Contributing to the low count

on the south beach were frequently passing automobiles; the north beach was deserted. Overall, Peregrine sightings averaged one every 20 miles of travel. All trapped birds appeared in excellent health, with fully developed pectoral muscles showing no signs of weight loss.

Occasionally marked Peregrines were resighted or retrapped. Since the positions of the dye mark and the wing hole (see Enderson, 1964) were varied on birds of the same age and sex, it was usually possible to recognize individuals at a distance. An immature female, banded on the south beach on 11 October and resighted there on 16 October, was retrapped near the point of banding by another worker on 17 October. Another immature female, banded on the south beach on 13 October, was retrapped on the north beach on 17 October about 80 miles farther north. An immature female, banded early on 15 October on the north beach, was retrapped there late that afternoon. Another immature female, banded on 15 October on the north beach was retrapped there early on 16 October, resighted in late afternoon, and again resighted the next day. Still another immature female was caught on 16 October on the north beach and seen again later the same day. These observations indicate that many individuals do not move rapidly through the area but may spend several days in one locality.

Finally, on 14 October 1964 I trapped an adult female on the south beach which had been banded there as an adult on 10 October 1962 by E. Skov. This bird was apparently migrating along the same route used 2 years before.

Although Peregrines were observed 52 times, 8 of these were clearly resightings, hence no more than 44 individuals were seen. These included 20 immature females, 16 adult females, 6 females of undetermined age, and 2 immature males. No adult males were encountered. These frequencies contrast with observations in Wisconsin, where of 131 migrant birds identified as to age and sex since 1947, 61 were immature females, 5 adult females, 53 were immature males, and 12 were adult males (D. Berger, pers. comm.).

Most of the Peregrines were seen sitting on the beach, on a piece of driftwood, or were seen after being flushed; nearly all that were not caught flew inland until lost from view. I saw no evidence of a north-to-south movement in the actions of the birds, and none flew from sight over the ocean. Sixty-five per cent of the falcons observed were seen before 10:30 AM, although I looked for them throughout the day. I found it interesting that although the last trip up the beach each evening, just before dark, flushed all the falcons inland, I saw many birds in the first trip down the beach the next morning. These falcons had arrived either late the previous evening, just before dawn that morning, or in the night. This was most conspicuous on the north beach where more Peregrines were seen. For example, on 16 October I saw 10 Peregrines in the first trip, one on the return, and 6 in the afternoon. On

FIG. 1. Movements of migrant Peregrines banded mostly in September, October, and November and recovered prior to the next summer. Numbers indicate weeks between banding and recovery.

the south beach 2 or 3 individuals would be seen on the first trip down the beach and none the remainder of the day.

Although large numbers of shorebirds were present, the only Peregrine seen with prey was carrying a Mourning Dove.

Banding recoveries of migrant peregrines.—A listing of the Peregrine band recoveries complete through November 1964, was obtained from the U.S. Fish and Wildlife Service. Of the 147 recoveries, nine were discarded because the birds were transported and released or hand-reared. An additional 70 records were of Peregrines banded as nestlings or resident adults in the United States or southern Canada. The remaining 68 records are apparently of migrant birds, banded mostly in September, October, and November in shoreline areas. Of these, 39 were recovered some distance away from the banding point before the following summer and are plotted in Figure 1. Included are two banded as nestlings on 31 July and 1 August in the Yukon and in Alaska, respectively. These birds presumably soon became migrants. Another bird, banded in October in Wisconsin and recovered in central Missouri in May, was possibly moving northward when recovered. The

movement of another Peregrine, banded in Denton, Texas, in October and recovered in Wisconsin in January, is difficult to explain. Probably it was caught elsewhere and transported, since Denton seems an unlikely place to capture a migrating Peregrine. The Panamanian recovery in Figure 1 was actually made at sea near that country. A Peregrine banded in North Carolina on 1 February and recovered at Key West in May is the only bird in Figure 1 banded after 7 November.

Of the remaining 29 records of migrants, 11 are of birds recovered within a few months near the point of banding and 18 are of migrants banded in the fall and recovered after the following spring. These latter records are listed in Table 1. The birds were presumably southward bound when banded and most were recovered on some subsequent northward or southward leg of their migration, or while wintering in South America.

Distribution of wintering peregrines in the United States.—Figure 2 shows the locations of Christmas Count sightings of Peregrines recorded for the years from 1947 to 1963 in Audubon Field Notes 2 (2) to 17 (2). (Since it represents a summation of records over a 16-year period the figure presents a slightly distorted picture.) Over much of the country the Peregrine Falcon winters very uncommonly, but in coastal areas Peregrines are often seen on Christmas Counts and are probably regular winter residents there.

On the eastern seaboard, from Virginia northward, 14 Peregrines were seen on the 1960 counts, 13 in 1961, 13 in 1962, and 9 in 1963. Of these 49 sightings, 14 were made within a few miles of New York City. These must be winter residents from the Arctic because local permanent residents became extirpated by 1961 (Herbert and Herbert, 1965).

Birds seen in the interior were very frequently associated with large rivers or waterfowl refuges, e.g., Monte Vista and Bear River National Wildlife Refuges in southern Colorado and northern Utah, respectively. Peregrines seen in the Puget Sound area are presumed to have been Peale's Falcons (*F. p. pealei*) (Beebe, 1960:177).

DISCUSSION

Reduction of the Breeding Population

Coincident with the apparent extirpation of the Peregrine population in eastern United States and in the upper midwest area is a reduction of this species in the Rocky Mountain region. Of 47 reported sites visited in this study in 1964 only 13 had pairs of Peregrines while 4 more had single adults. Judging from records in the literature (Cameron, 1907; Taverner, 1919), Peregrines once nested along rivers coursing eastward from the mountains across the plains in Montana and Alberta. I found only a single unmated Peregrine in this type of habitat. Equally conspicuous is the reduction of

TABLE 1
RECORDS OF MIGRANT PEREGRINES BANDED IN THE FALL AND RECOVERED IN OR AFTER THE NEXT FALL

	Banded		Recovered	
	Date	Locality	Date	Locality
1.	7 October 1937	Wisconsin	7 October 1939	Wisconsin
2.	28 September 1938	Wisconsin	30 June 1946	Manitoba
3.	26 September 1939	North Dakota	11 January 1941	Oklahoma
4.	15 October 1939	New Jersey	25 October 1942	Maryland
5.	18 October 1939	Maryland	5 November 1944	Bolivia
6.	1 October 1941	Wisconsin	10–20 November 1942	Tennessee
7.	7 October 1941	Wisconsin	5 May 1947	central Ontario
8.	6 November 1946	Virginia	5 October 1947	Virginia
9.	11 October 1950	Washington, D.C.	1–10 October 1957	Ecuador
10.	7 October 1951	Maryland	8 May 1953	Columbia
11.	2 October 1952	Maryland	16 February 1957	Uruguay
12.	26 October 1952	Texas	20–30 September 1953	Texas
13.	25 October 1953	Maryland	29 November 1954	Virginia
14.	13 October 1954	Texas	21 June 1955	Texas
15.	8 October 1955	Wisconsin	Spring 1961	Alabama
16.	8 October 1955	Maryland	22 March 1959	Ecuador
17.	5 October 1956	Maryland	November 1959	Greenland
18.	10 October 1957	Maryland	4 September 1958	Greenland

Peregrines in a once forested region of central Alberta. On one river they were to be found about every 10 miles in the 1920's (K. Wood, pers. comm.); I found only one occupied site on a 95-mile section of the stream. However, four Prairie Falcon nest-sites were found. This new resident has apparently been able to invade the area in recent years due to the clearing of trees and resulting conversion of the region into suitable habitat. Possibly Prairie Falcons have been able to occupy the limited nesting sites at the expense of Peregrines, because the former species winter nearby in southern Alberta and perhaps choose nest-sites before the arrival of Peregrines in the spring. On another river in Alberta, a 22-mile section had six pairs of Peregrines in 1958 (A. Oeming, pers. comm.), but I found no birds there in 1964. At two adjacent but very remote sites in Montana which were active in the early 1940's (R. Elgas, pers. comm.). I found no evidence of recent occupancy.

The causes of this reduction are largely unknown. Egg collectors have visited some of the Alberta sites regularly for the past several years. Oil survey crews have traveled the rivers in Alberta during the last decade and have been blamed for shooting Peregrines. The young from several sites in Alberta have been taken into captivity. In Colorado, falconers have recently

FIG. 2. Composite of Audubon Christmas Count Sightings of Peregrines from 1947 through 1963.

become aware of the presence of nesting Peregrines but only one young was taken in 1964. Pesticides apparently have had harmful effects on the Peregrine population of Great Britain (Cramp, 1963), but it is difficult to understand how they could have affected Peregrines in the region studied where the similar Prairie Falcon seems to be thriving. The two species presumably take similar prey in Alberta, except that Prairie Falcons probably capture more small mammals.

There is no question that Peregrines in the eastern United States were greatly molested by man. Of 58 nestling Peregrines banded in that region and later recovered, 45 were recovered before reaching 2 years of age, the age of sexual maturity. And of the 58, 31 were shot, trapped, or poisoned. Certainly many of the others, recovered by unknown means or found dead or injured, were directly molested. Herbert and Herbert (1965:83, 90), referring to the 1949–55 period of decline of Peregrines near New York City, state that nesting birds were molested by road building, falconers, and shooting, and that nesting failure, particularly the abandonment of clutches before hatching time, was conspicuous. However, in the war years, when these deterrents were less, nesting was more successful than at any time since around 1930. Correspondingly, D. Berger (unpublished data) found that nesting sites in

eastern United States became unoccupied after first, failure of the birds to hatch eggs, and second, in subsequent seasons, failure to lay. Irrespective of the possibility of pesticide poisoning, it seems apparent that direct human interference was a major factor in the decline in the eastern United States and that this factor is now operating in the region I surveyed.

In the Rocky Mountain region, the Peregrine exists only where very local conditions are favorable. Not adapted to arid regions, it is found there near rivers or reservoirs where shorebirds and waterfowl are found, and where land birds are vulnerable to attack over water. Other pairs are found on the highest cliffs, often on mountains, where high-flying land birds may be taken as prey. Finally, that Peregrines in these local favorable areas are not more numerous than they are may be due in part to the fact that the young disperse into surrounding unfavorable regions and are frequently lost.

It is very difficult to estimate the number of pairs of Peregrines breeding in the region surveyed. Judging from the frequency with which I found pairs and from the amount of suitable habitat, it seems very unlikely that more than 25 pairs nest in Colorado and Wyoming. Mountainous regions of Montana probably have no more than this. Alberta has more pairs, perhaps as many as 60, considering the large rivers in northern Alberta. However, along the Athabasca River, I saw little evidence of nesting and no occupied sites.

Migration and wintering

Apparently distinct from the dwindling population of weakly or non-migratory Peregrines breeding in the temperate areas of North America is a large, highly migratory population of Peregrines breeding in the Arctic (Cade, 1960). These latter birds are commonly referred to as "arctic" or "tundra" Peregrines (Beebe, 1960:150). Of 67 Peregrines evidently banded as nestlings and 3 others banded as adults, presumably at nest-sites, in the United States and southern Canada, only one was recovered south of central Georgia or southern California (in Mexico), and none north of southern Canada. In sharp contrast, 19 of 68 presumed "arctic" migrants, banded in the fall in the United States, were recovered in the West Indies, Central America, and South America as far south as southern Argentina; another four were recovered in Canada or Greenland (Figure 1 and Table 1) while most of the remaining 45 were either banded on the Gulf Coast or showed marked movement to the south.

The evidence for an annual round-trip migration from the Arctic to southerly wintering regions and back is scanty, particularly in regard to immature birds. Only three records of "arctic" birds, banded as nestlings, show fall movement from the breeding grounds into more temperate regions, but relatively few "arctic" nestlings have been banded. On the other hand, four adults, presumably banded as migrants, were recovered substantially north

of the banding points (see Table 1, records #2, 7, 17, and 18). The first two, recovered in spring, were probably at their nest-sites.

Cade (1960) thinks it possible that Peregrines do not return to the Arctic until they are 2 years old; he has not seen yearlings in Alaska. Actually, only two adults have been recovered in the Arctic. There are four records of immatures being recovered in Central or South America in April and May, and two others in those months recovered in southern United States. However, these may have been moving northward since even adults do not arrive in the Arctic until mid-May (Cade, 1960).

Peregrines do winter in the United States, and the majority shown in Figure 2 must be "arctic" birds since the local residents became greatly reduced in the last 15 years (D. Berger, unpublished data). Supporting this contention are records of 11 birds, banded in, or in one case, just prior to, the migration and recovered in the United States in December, January, or February. One other was banded in North Carolina in February bringing the number of records of U.S. wintering "arctic" Peregrines to 12, or about one-sixth of the 68 migrant recoveries. Wintering "arctic" Peregrines are in evidence in south Texas until March (R. L. Meredith, pers. comm.).

The first migrating "arctic" Peregrines apparently reach north-central United States in early September. On the shore of Lake Superior, through several seasons, one observer recorded the first migrant on 11 September (R. Widmeier, pers. comm.). In Wisconsin, of about 360 sightings of Peregrines in 12 nonconsecutive years in the period 1951–64, only three birds were seen in the first week of September (D. Berger, pers. comm.). The bulk of the migration occurred there in the period between 22 September and 5 October when 218 were seen, and the migration is nearly over by the last week of October when only three were seen. Judging from banding data, the flight southward across the United States requires 1 or 2 weeks, placing the majority of migrating Peregrines on the Gulf Coast in the first half of October. This agrees with observations in that region (D. Slowe, K. Riddle; pers. comm.).

SUMMARY

In spring and early summer, 1964, I visited 47 of 52 known nest-sites of Peregrine Falcons in the region from Colorado to central Alberta, mostly east of the Continental Divide. Of the 47, only 13 were occupied by pairs of Peregrines, including 6 in Colorado, 1 in Wyoming, and 6 in Alberta. I saw an unmated bird in Colorado and in Montana and two in Alberta. I did not visit three other recently used sites in Montana. Of the 8 unoccupied sites in Colorado, 5 were used as late as 1960, and in Alberta, 6 of 11 unoccupied sites were used as late as 1959. Five young are known to have fledged from the Colorado sites, and I saw 14 young in the six occupied Alberta sites.

From 10 to 17 October 1964 I counted, marked, and banded Peregrines on the Texas Gulf coast. In this period I drove 1,052 miles and saw 52 Peregrines, or about one per

20 miles. Five immature females were resighted up to 6 days after release, showing that some Peregrines do not move quickly from the area. One went about 80 miles northward from the banding point. Since eight resightings were made, only 44 individuals were seen, and these included 20 immature females, 16 adult females, 6 females of undetermined age, and 2 immature males. It appeared that Peregrines moved to the seashore in the night because few were seen just before sunset and many were seen at dawn.

Banding records indicate many Peregrines, presumed to be "arctic" birds, migrate to Central and South America to winter. Migrants reach the northern border of the United States in the first week of September and dwindle to only a few by the last week in October. Peregrines winter rarely in the United States, except in coastal areas. They are especially conspicuous on the Atlantic and Gulf Coasts, and most must be "arctic" birds since the eastern resident population has virtually disappeared.

The reasons for the reduction of nesting Peregrines in the Rocky Mountain region are largely unknown, but I think that direct human interference is a major deterrent.

ACKNOWLEDGMENTS

In preparing this paper I have relied heavily on the field records of many people and I owe them thanks for their contributions. Clayton White offered valuable assistance during the Gulf Coast count. I am grateful to Daniel Berger and Tom J. Cade for carefully criticizing the manuscript.

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18 JANUARY 1965

RELATIONS BETWEEN RAPTORS AND COLUMBIFORM BIRDS AT A DESERT WATER HOLE

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Doves, pigeons, and sandgrouse are notably wary in approaching the isolated and usually exposed, open water holes where they congregate in large numbers to drink in desert regions, as, for instance, in parts of Australia (Cameron, 1938) and Africa (Bowen, 1927). What are the hazards which make such obvious behavior of adaptive significance in the lives of these birds? During fieldwork carried out between 18 and 23 January and between 5 July and 11 August 1964 in the Namib Desert, I had frequent opportunities to observe flocks of columbiform birds drinking at a water hole in the dry bed of the Kuiseb River and to gain some insight into the role which diurnal raptors play in determining their approach to water.

LOCATION AND ENVIRONMENT

These observations were made at the Namib Desert Research Station located at Gobabeb, approximately 70 miles inland from Walvis Bay, in Southwest Africa. An open pit dug down through sand to the water table in the bed of the Kuiseb River provides one of the six or eight sources of surface water for thousands of square miles in this region. The diameter of the pit at the level of the river bed was about 40 feet, the depth to the water, about 10 feet, while the diameter of the water surface itself was about 6 feet. The well is located approximately in the center of the riverbed, where its width is some 250 feet. On either side there are stands of rather dense riparian woods consisting mainly of *Acacia giraffae* and *Acacia albida* growing to a height of 40 to 50 feet. Vegetationless sand dunes stretch southward from the left limit of the river for hundreds of miles. Northward lies an equally vast expanse of sparsely vegetated gravel plains. Most of the birds in this region are necessarily associated with the river valley or with the better vegetated portions of the gravel plains.

OBSERVATIONS

Five species of columbiform birds were regular users of this water hole during my periods of observation. These were: Namaqua Sandgrouse (*Pterocles namaqua*), Speckled Rock Pigeon (*Columba guinea*), Cape Turtle Dove (*Streptopelia capicola*), Laughing Dove (*Stigmatopelia senegalensis*), and Namaqua Dove (*Oena capensis*). Mackworth-Praed and Grant (1962) can be consulted for a description of these species.

In January, 200 to 300 Namaqua Sandgrouse came to water every morning between 0800 and 1200, the majority before 1000; but in July and August the number was reduced to 50 or less, and flocks did not visit the water every day. These sandgrouse arrived over the gravel plain from sparse grasslands located about 15 to 20 miles north and northeast of Gobabeb, usually flying high in flocks of 5 to 20 birds and repeatedly uttering a characteristic flight call. Typically an incoming flock circled once or twice over the water hole and then landed on a conspicuous rocky promontory overlooking the entire river valley about 500 yards upriver from the water on the left limit. Sometimes dozens of sandgrouse, sitting with alert, up-stretched necks, accumulated on the knoll before the first groups flew down into the river bed to the water.

Small groups (possibly the same as the incoming flocks) usually began flying down into the riverbed about half an hour after the first birds had arrived on the knoll. They never flew directly down into the pit to the water but landed instead on the sandy riverbed 10 to 50 feet or more away and cautiously walked into the pit to the edge of the water. Any slight disturbance at this time caused all or part of the approaching sandgrouse to bolt and fly back to the knoll. Once at the water, some of the birds (males) immediately waded in up to their breasts to drink and wet their breast feathers, while others drank from the edge. Drinking and wetting the feathers were brief acts requiring no more than 10 to 15 seconds for completion after the water was reached. Each bird flew up directly from the spot where it had drunk, in or out of the water; and the departing groups burst forth from the pit with great commotion, gained altitude over the river, and disappeared northward over the gravel plain, usually without calling. As the first groups flew down to water in this fashion, other flocks were still arriving on the knoll, and at the peak period around 0930, groups of sandgrouse followed after one another into the pit in quick succession.

During July and August a flock of nine Rock Pigeons came fairly regularly to water at Gobabeb; but these birds did not appear every day, and the number dwindled to seven during the period of observation. These pigeons apparently came from a foraging area farther upriver, but their exact movements were not determined. They appeared at various times of the day from early morning to late evening, and when they flew into the sector of the river where the water hole is located, they invariably settled as a group in the uppermost branches of one of the tallest acacias growing on either side of the well. The pigeons often remained perched in the tree for half an hour or more before flying down to the perimeter of the pit. There they again sat for several minutes looking down at the water but seemingly hesitating to walk down into the pit to drink. If some doves or other small birds happened

to fly to the water at this time and began drinking, their behavior seemed to stimulate the pigeons, for then the latter walked hurriedly down the sloping side of the pit to the water and also began drinking. The pigeons usually walked part of the way back up the side of the pit before flying off.

Several hundred Laughing Doves and a few dozen Cape Turtle Doves came to water daily at Gobabeb. Most of these doves watered before 1000 and after 1600, but a few could be observed flying to water all through the day. Typically these doves approached the water hole flying singly or in groups of two to three along the river course and perched first in one of the tall acacias growing nearby. Particularly in the early morning and late evening periods of peak visitation, 100 to 200 doves usually accumulated in the trees before the first ones flew down to water. Many false starts were made, but once the first group of six to eight birds finally settled at the edge of the water, these doves followed after one another in a steady stream of small parties until all had watered. They left the trees with several hard flaps on a downward course, then set their wings and planed swiftly right into the pit, landing near the edge of the water. Drinking lasted only a few seconds before the doves flew out of the pit and back into the trees. At the peak periods there was a steady two-way traffic between the trees and the water, and sometimes incoming birds collided in the air with those leaving the pit.

The ground-dwelling Namaqua Dove used a different approach. Several dozen of these small, fast-flying doves watered at Gobabeb. They were much more likely to appear in the middle portion of the day than in the early morning or late evening. They came singly or in pairs and usually landed first at the edge of the riverbed on the ground under the acacias or under the stands of *Nicotiana glauca* growing farther out in the bed of the river. After sitting motionless for a few minutes, they flew quickly just over the surface of the sand and dropped down into the pit to drink. Again, they were at the water only a few seconds before flying away.

Raptors which hunted regularly in the vicinity of the water hole at Gobabeb were: an immature male Lanner (*Falco biarmicus*), a pair of Rock Kestrels (*Falco tinnunculus*), an immature male Gabar Goshawk (*Micronisus* [= *Melierax* according to some authors] *gabar*), and a pair of Chanting Goshawks (*Melierax musicus*), the male fully adult, the female just beginning molt into adult plumage. There was no indication that the kestrels paid special attention to the movements of potential prey around the water hole, but the other four raptors definitely did. The Lanner had several high perches on dead branches in the tops of nearby acacias, where he could be seen sitting and watching the water every day. At times he also circled high over the river directly above the water hole. The little Gabar Goshawk was often perched motionless inside the branches of an acacia growing near the

water, a habit which is especially conspicuous among individuals of the same species at isolated wells in the Kalahari Gemsbok National Park. The Chanting Goshawks patrolled a regular beat up and down the river past the water hole, and at times they perched on the same branches used by the Lanner. Unlike the other raptors, these goshawks also frequently flew down into the water hole to drink.

Although the remains of doves were found frequently in the vicinity, the only one of these hawks which I actually saw attacking and killing birds at the water hole was the Lanner. His usual tactic was to stoop from one of his high perches, or from a circling position over the river, when a group of doves left the acacias and set their wings to glide down into the water hole. More often than not he missed, and even when he did strike down a bird he was not always successful in retrieving it. Twice I saw him knock Laughing Doves into the riverbed, but before he could turn to pick them up, the injured birds managed to struggle into cover growing at the edge of the river.

Injured doves were seen around the water hole several times, and in one notable instance a Laughing Dove which could not fly actually walked from the protective vegetation at the edge of the riverbed, out over the open sand, down into the pit, drank, and walked back. Such birds undoubtedly fall victim to some predator sooner or later, and the Lanner may indirectly provide much of the prey eaten by less vigorous hunters like the Chanting Goshawks, as the following episode illustrates.

On 8 August at 1010 hours while watching from a blind about 20 feet from the water, I heard the Lanner stoop overhead. There was a loud whack in the air, and an injured Cape Turtle Dove fell right into the water, where it was able to support itself on some floating moss by spreading its wings and tail. The Lanner did not persist in his attack. Soon the dove stuck its beak into the water and drank deeply for several seconds, while still floating in the moss. It then managed to flap across the surface to the edge of the water, where it lay in the wet sand breathing heavily. A Laughing Dove landed at the edge of the water at 1019 but flew up in panic almost immediately, as the Lanner swooped in low over the pit. The Lanner evidently saw the injured Turtle Dove, for he returned to stoop over it twice; but the dove "froze" in a crouched posture, and the Lanner did not descend to pick it up. At 1029 the injured dove stood up and managed to walk into the dry sand to a point just where the sloping side of the pit swings upward. It then settled down again beside a stick in full sunshine and began panting.

At 1035 the female Chanting Goshawk suddenly landed at the periphery of the pit, scaring away several small birds which had been drinking. The injured Turtle Dove "froze" by the stick, and the goshawk did not appear to see it. The Chanting Goshawk had walked about halfway down into the pit

when a small flock of sandgrouse flew directly over, and their passage evidently caused the dove to bolt. It fluttered across the sandy bottom of the pit and came to rest against the grounded side of an old oil drum which was half submerged in the water. The suddenness of its movement frightened the goshawk, and she flew back to the periphery of the pit, where she stood motionless looking intently down toward the dove, which was cowering in plain sight against the drum. At 1040 the dove suddenly jerked convulsively and toppled over dead at the edge of the water by the drum. The Chanting Goshawk was still watching. At 1042 the goshawk flew down into the pit to a sector of the water on the side of the drum opposite to that where the dove lay. She waded into the water up over her toes, and during the next 12 minutes drank a total of 28 beak-fulls of water by tipping up. Next, she stepped out of the water, slowly looked about, and walked deliberately around to the back of the drum, where she stopped. Peering carefully around the drum on the side where the dove lay, she moved a little closer and suddenly struck out with one of her long legs, gripping the dove tightly with her talons. The goshawk stood erect looking about a few more seconds and then flew off at 1100 with the dove in her foot.

SUMMARY AND CONCLUSIONS

The behavior of five columbiform species at the Gobabeb water hole suggests that these birds are most vulnerable to capture while actually at the water drinking and while approaching or leaving the water across the open bed of the river. Miller and Stebbins (1964) describe instances of a parallel kind of vulnerability of quail (*Lophortyx gambelii* and *Oreortyx pictus*) during their visits to water holes in the Joshua Tree National Monument, in the Mojave Desert of California. The columbiforms have evolved a mechanism of drinking which enables them to take in a sufficient quantity of water in a very short time by sucking, an obvious advantage in reducing exposure to possible predation. See Bartholomew and Dawson (1954) for details about the drinking capacity of Mourning Doves (*Zenaidura macroura*). Secondly, in their approach to the water hole none of these columbiform species flies directly to the water to drink but waits first in some relatively protected position nearby to survey the situation.

The implication that these patterns of behavior in columbiforms have developed in response to predators is reinforced by observations on the habits of sympatric falconiforms, which do indeed hunt selectively around water holes and which do take advantage of the vulnerability of birds exposed by their use of open water. Moreover, it seems likely that these patterns of behavior are chiefly for avoiding capture by diurnal birds of prey and have

been little influenced by owls or mammalian predators, which mostly visit the water holes at night.

ACKNOWLEDGMENTS

These observations were made during work supported by a grant from the Public Health Service (Environmental Health) ES 00008. I thank E. J. Willoughby and L. I. Greenwald for assistance in the field.

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CLIFF-NESTING ADAPTATIONS OF THE GALÁPAGOS SWALLOW-TAILED GULL[1]

Jack P. Hailman

E. Cullen (1957) showed that the cliff-nesting Black-legged Kittiwake (*Larus* (*Rissa*) *tridactylus*) differs from "typical" (i.e., ground-nesting) gulls in many respects. The species' unique morphological and behavioral characters. Cullen cogently argued, have resulted from adaptation (either directly or indirectly) to cliff-breeding. Epistemologically, the correlation between cliff-nesting and unusual characters constitutes a hypothesis that must be "tested" independently on a relatively unrelated cliff-nesting gull. Therefore, while I was studying the chick-feeding behavior of the cliff-nesting Galápagos Swallow-tailed Gull (*Larus* (*Creagrus*) *furcatus*) I noted the general habits of this species for comparison with the Kittiwake.

METHODS

The results of observations of the colony on southern Plazas Island off Santa Cruz (Indefatigable) Island and of several colonies on Tower Island, made during November, 1962, are presented in tabular form with explanatory comments in the text. The observations are compared with characteristics of the Kittiwake and "typical" ground-nesting gulls.

The horizontal distance from the outer edge of the nest to the edge of the nesting ledge was measured with a tape measure in the beginning, and later estimated by eye; the vertical height of the nest above the sea was estimated by eye. Behavioral observations were made with binoculars and in some cases recorded photographically with still and motion pictures. Notes on the nocturnal habits, breeding cycle, and displays of *furcatus* are presented elsewhere (Hailman, 1964*c*, 1964*a*, and in prep., respectively).

In this and other publications on gulls I have followed the latest family revision (Moynihan, 1959), which assigns all species of gulls to the genus *Larus*. Except where noted, all information on the Kittiwake's adaptations has been taken from Cullen (1957). Information for comparisons with "typical, ground-nesting gulls" has come primarily from Cullen (1957), my unpublished notes on *Larus atricilla*, Tinbergen (1953), and accounts in Bent (1921).

In the "visual cliff" experiment reported below, a standard, albeit makeshift, visual cliff apparatus (Fig. 3) was made from a wooden box 16.5 inches long, 11 inches wide, and 9 inches deep. Across the glass top ran a center

[1] To Ernst Mayr (on the occasion of his 60th birthday), who taught me that the study of whole animals is not only an intellectually respectable pursuit but moreover an exciting life's devotion.

strip of black tape (3.5 inches wide) upon which the chick stood. To one side of the strip was the plain glass ("deep" side), under which the inside of the box lined with square-ruled paper (0.9 mm squares) could be seen. On the other ("shallow") side, ruled paper lined the underside of the glass. Each chick was placed in the center of the strip under a small translucent box for a 30-second habituation period, after which the box was lifted and timing with a stop-watch begun. Ten newly hatched *furcatus* chicks raised from the egg in a dark incubator were tested. The chick was scored as having chosen a side (i.e., deep or shallow) if it placed one foot on that side so that the foot did not touch the center strip. If no choice was made within 10 minutes, the chick was scored as "no choice" and was gently pushed toward the deep side or pinched in order to force a choice.

CLIFF-NESTING OF THE SWALLOW-TAILED GULL

The actual cliff habitat.—There are certain important differences between the "cliff" habitat of the Swallow-tailed Gull and the Kittiwakes. (1) The Swallow-tail nests on lava ledges or barancas whose angle varies from vertical to nearly horizontal, while the Kittiwake nests almost exclusively on vertical cliffs. (2) The two gulls nest at different heights, the Kittiwake sometimes very high (130 meters), the Swallow-tail at variable heights (1 to 25 meters), rarely higher than 8 meters (Fig. 1). (3) The Kittiwake's cliff almost always overlooks the sea, while that of the Swallow-tailed Gull may overlook land near the water (e.g., the colony in NW corner of Darwin Bay on Tower Island). (4) Similarly, flat land at the top or foot of the nesting cliff, or at least near it, is available to Swallow-tails for display activities; this is usually not so true for Kittiwakes. (5) Finally, the distance from the nest to the edge of the cliff gives some idea of the restriction of living space and of the likelihood of eggs or chicks falling off the cliff. Minimum distances from the center of the nest to the edge are shown in Figure 1 for a sample of 41 nests of the colony at Plazas. Apparently all Kittiwakes nest on ledges which just barely hold a nest and two standing adults, so each nest is placed at about the shortest distance found for the Swallow-tailed Gull (25–50 cm). (Recently, however, Kittiwakes have begun nesting on flat ground; see Paludan, 1955; Coulson, 1963).

Possible selective pressures producing cliff-nesting habits.—Cullen (1957) believes that the Kittiwake's cliff-nesting is an adaptation to avoid predation on the eggs and chicks, and even upon the adults. Predation is probably unimportant in the Swallow-tailed Gull (see below), since its nest predators would be primarily aerial (and thus would have access to the nest) no matter where the gulls nested in the Galapagos (Hailman, 1964*c*). However, even aerial predators, such as Frigatebirds (*Fregata* spp.) may have difficulty

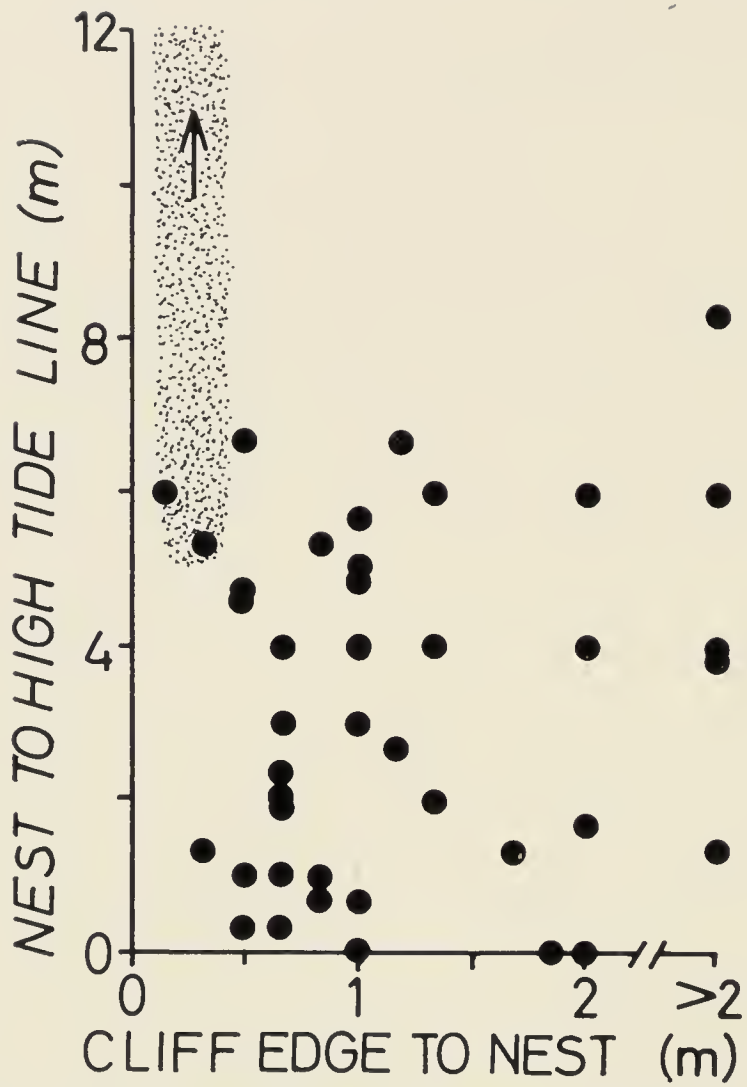

FIG. 1. Sites of 41 active nests of *Larus furcatus* on South Plazas Island, November 1962. The median height is 4 meters above the sea. The stippled portion indicates nest sites of *Larus tridactylus*, which go to above 130 meters, with median values of 15–35 meters above the sea (Coulson, 1963).

landing on narrow ledges; aerial predators also have difficulty landing on the Kittiwake's ledges. The Swallow-tailed Gull's cliff-nesting might be linked in some way with pelagic habits; such an idea, if correct, would probably also apply to the Kittiwake. Also, the *furcatus* population may merely have exploited an unoccupied niche. The number of "typical" nesting sites for gulls (high grass in sand dunes or marshy area) is severely restricted in the Galápagos. which may account for the small population of the endemic Lava Gull (*L. fuliginosus*), a "typical species." (Food may also limit *fuliginosus* due to competition with other species for refuse; Hailman, 1963.)

ENVIRONMENTAL CONDITIONS AND CORRELATED CHARACTERISTICS

"Selective pressures" accompanying cliff-nesting.—The multiple differences from typical gulls shown by the Kittiwake are presumably the results of sev-

eral separate selective pressures. Probably only some of these selective pressures act on *furcatus*, partly because of the habitat differences (above). Thus, if Cullen's hypothesis be correct, the relatively unrelated Swallow-tailed Gull should prove convergent with the Kittiwake in those characters presumably related to situations that both species experience; in other respects the Swallow-tail should resemble typical gulls.

Specifically, the special environmental conditions experienced by the Kittiwake as a result of its cliff-nesting habits are: (1) reduced room for nesting; (2) scarcity of nesting sites; (3) scarcity of nest materials; (4) relaxation of predation on nest and eggs; and (5) danger of eggs rolling off cliff and chicks falling off cliff. (I have altered this classification somewhat from Cullen's presentation.)

(*1*) *Reduced room for nesting.*—The nesting space of individual pairs of cliff-nesting birds is limited to small ledges, particularly if all possible nest-sites are utilized by the species. To hold as large a territory around its nest as does a ground-nesting gull, the ancestral cliff-nesting gull would have had to defend many separate ledges. Deviant individuals psychologically "satisfied" with defending merely the nesting ledge might have left more offspring because parental care improved with lessening of territorial disputes (see discussion of "aggressive neglect" in Hutchinson and MacArthur, 1959). The converse holds for ground-nesters, which gain an anti-predator advantage by spacing-out.

Some problems arising from this reduced living-space are: (a) reduced space for territorial "fighting" and display; (b) reduced room for display and copulation between mates; (c) undue hostility aroused between mates because of continual propinquity; and (d) fouling of the nest. Some adaptations to these problems are summarized in Table 1, and further explained by the following notes.

In the early part of the nesting season, Kittiwakes display on the water at the foot of the cliff (Tinbergen, 1958). That Swallow-tailed Gulls do not appear to do this might be explained by the fact that they have available other areas for display (see above). Twice I observed copulation on flat land near the nesting-cliffs but never saw it on the cliffs (which were watched for much longer periods of time). E. Curio (pers. comm.) also observed copulation once on the flat surface of a large rock. Allo-preening within the pair (J. M. Cullen, 1962) is probably a "display" evolved to reduce hostility. (This characteristic was not commented upon by E. Cullen, 1957, but was discovered in the cliff-nesting tern *Anous tenuirostris* by J. M. Cullen and Ashmole: see Postscript to this paper.)

Appeasement Head-flagging exhibited between Kittiwake chicks is absent

TABLE 1

CHARACTERISTICS PRESUMABLY RELATED TO AMOUNT OF NESTING SPACE

SPECIES	TYPICAL GULLS	SWALLOW-TAILED GULL	KITTIWAKE
Living Space:	Large	Reduced	Small
1. Fighting			
a. frequency	frequent	infrequent (?)	frequent
2. Displays			
*a. chasing and moving displays	several	none (?)	a few
*b. long distance displays	several	none (?)	a few
*c. upright threat	common	absent (?)	absent
d. Long Call ceremony	loud	silent (?)	"Kittiwaking" (?)
*e. pairing displays	on pairing territory	occasionally on flat land	occasionally at base of cliff (and top of)
3. Copulation			
*a. where	on ground	on ground	on ledge
*b. female	stands	stands	sits on tarsi
4. Hostility Reduction			
*a. allo-preening (pairs)	absent (?)	present	present
*b. Head-flagging (adults)	uncommon	uncommon (?)	common (in certain situations)
*c. Head-flagging (chicks)	absent	(never seen)	present
*d. dark neck band	absent	immatures	chicks
5. Prevention of Fouling			
a. older chick defecates (cf. Table 4:2e)	off nest	over ledge	off nest or over ledge
b. eggshells (cf. Table 4:1d)	parents remove or eat	parents remove	not removed

* See Table 6.

in *furcatus*, which has only one chick per clutch. (I saw Head-flagging, or something like it, only twice in adult birds.) I do not know whether or not strange Swallow-tail adults landing on a nest tend to peck the chick; in this situation the Kittiwake chick Head-flags. The very dark neck band of *tridactylus* chicks used in appeasement ("Bill hiding"—Cullen, 1957: Figure 1) is likewise absent in *furcatus* chicks. However, such a neck band is found in white-plumaged (prefledged) immature birds, which interact with their parents and possibly birds on other territories. (This band is shown in Hailman, 1964*c*: Figure 2.)

(2) *Scarcity of nesting sites.*—The Swallow-tailed Gull may breed at any time of the year (Hailman, 1964*a*; Leveque, 1964:87), although Snow (Hatch, pers. comm.) has found recent evidence that individual pairs breed on a 10-month cycle. Furthermore, synchrony of breeding is pronounced only in local areas, not on whole islands or between islands (Hailman, 1964*a*), although Snow's recent observations and also those of E. Curio indicate a general

TABLE 2

CHARACTERISTICS PRESUMABLY RELATED TO AVAILABILITY OF NESTING SITES

SPECIES:	TYPICAL GULLS	SWALLOW-TAILED	KITTIWAKE
Nesting Sites:	Abundant	Ample (?)	Scarce
1. Reduction of Competition			
a. breeding	seasonal	probably a 10-month cycle, with islands not in phase	seasonal
b. site	stereotyped	varied	stereotyped
2. Territory			
*a. when assumed	after pairing	probably after pairing	before pairing
b. guarding before first egg laid (cf. Table 3:3b)	rare	sometimes	always, but not necessarily continuously

* See Table 6.

synchrony within whole colonies as well (Curio, pers. comm.). Therefore the competition for nesting sites might be less acute than in the seasonally breeding Kittiwake. Furthermore, on Tower Island I noticed many unused areas that seemed to me capable of supporting *furcatus* nests. However, this situation seems to be true of Kittiwakes as well. The real competition for nest sites may be for nest sites *near other pairs*. Probably as a result of a reduced competition for nest sites, the territory of the ledge is not guarded (at night) before the egg is laid as strongly as after this time. Adaptations to nesting space are summarized in Table 2.

(3) *Scarcity of nest materials.*—Kittiwakes compete for nesting material because vegetation does not grow on the breeding cliffs. For such materials, the birds must go to flatter land, which they "fear" (Cullen, 1957). The Swallow-tailed Gull solves the vegetation shortage by using lava stones (Fig. 2), and sometimes coral fragments and sea urchin spines, all of which I found abundantly near the nests in which they occurred. This difference in abundance of materials correlates well with the multiple differences between the two species (Table 3).

There is some local synchrony of the general breeding cycle among *furcatus* pairs within sight and sound of one another. However, this synchrony may be an "accidental" extension of the normal responses to displays of the mate (i.e., a sort of "behavioral pleiotropism") and may not have been specifically selected for (Hailman, 1964*a*). The Swallow-tailed Gull's synchrony is certainly not as remarkable as the specific synchrony of building found in Kittiwakes. The latter's unique building synchrony was thought to be due to the availability of mud only on rainy days and to the social process of inland collecting (Cullen, 1957).

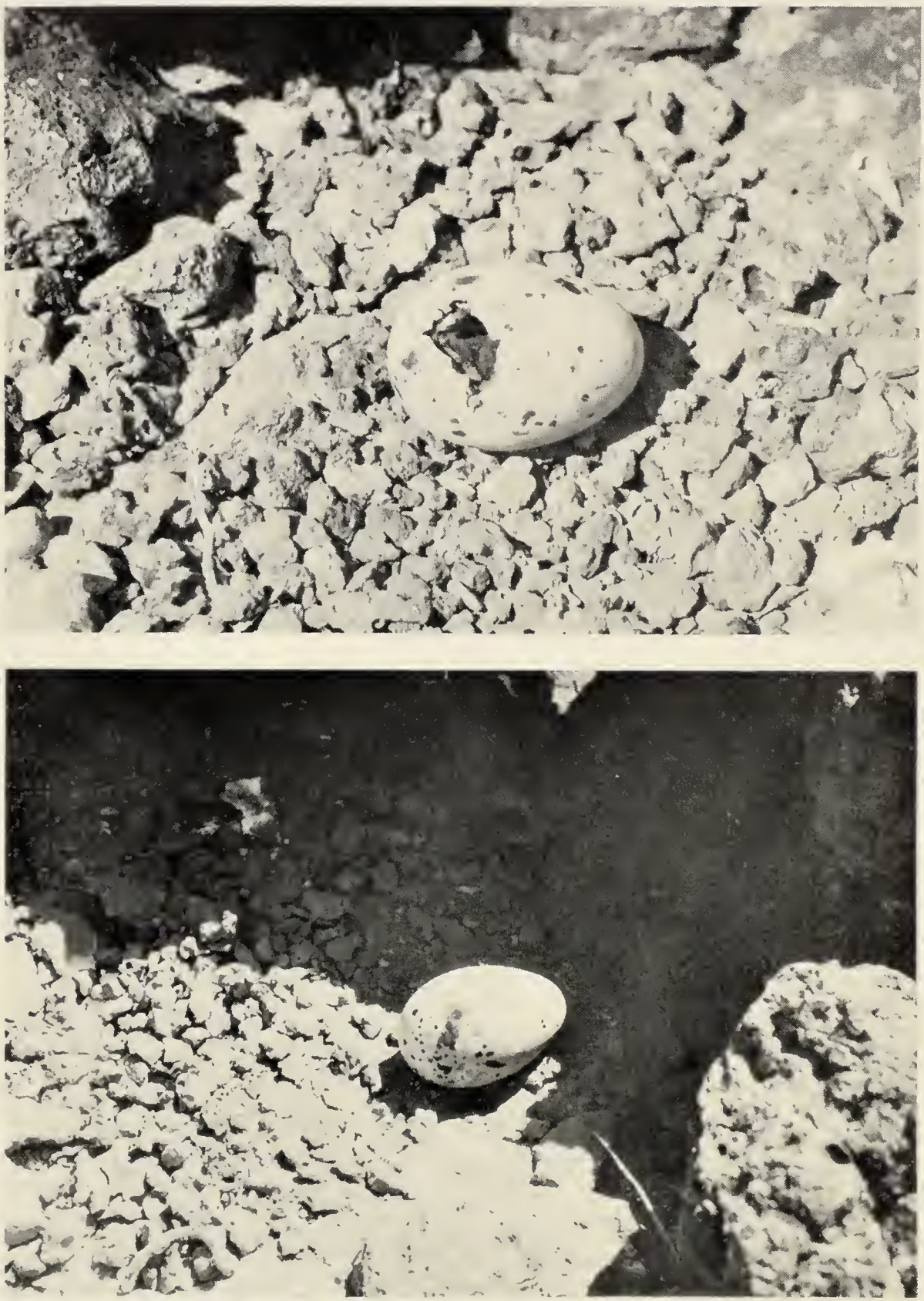

FIG. 2. Nests of *Larus furcatus*. a. (above) a typical nest of lava stones. The white egg tooth on the chick's bill is visible in the pipped hole. b. (below) A less structured nest placed under overhanging rocks, presumably for protection from the hot sun. In some areas, nests contain sea urchin spines and shells, as well as lava stones.

TABLE 3

CHARACTERISTICS PRESUMABLY RELATED TO AVAILABILITY OF NESTING MATERIALS

SPECIES:	TYPICAL GULLS	SWALLOW-TAILED	KITTIWAKE
Materials:	Abound	Abound	Scarce
1. Nest Materials			
a. materials used	vegetation	lava stones	mud and vegetation
*b. place	near nest	near nest	distant areas
*c. collecting	individual	individual	social
2. Building Nest			
*a. timing	individual	individual	synchronized
*b. technique	simple	simple	elaborate
3. Stealing from Other Nests			
*a. frequency	seldom	seldom	often
b. guarding before first egg laid (cf. Table 2:2b)	rare	sometimes	always

* See Table 6.

(4) *Predation at the nest.*—In Kittiwakes, nest predation (e.g., by foxes) is virtually eliminated because of the inaccessibility of the nest. However, in the Galapagos there are relatively few potential predators that cannot fly (e.g., two species of native rats which, however, climb readily) so the cliff-nesting habit of *furcatus* has not completely eliminated nest predation. Frigatebirds (*Fregata magnificens* and *F. minor*), which abound in the Galapagos, regularly patrol the nesting-cliffs. Furthermore, the native owl *Asio galapagoensis*

TABLE 4

CHARACTERISTICS PRESUMABLY RELATED TO AMOUNT OF NEST PREDATION

SPECIES:	TYPICAL GULLS	SWALLOW-TAILED	KITTIWAKE
Nest predators:	Aerial and ground	Aerial	(none)
1. Parental Protection			
*a. alarm call	frequent	frequent	rare
*b. flight distance	far	variable (far to very near)	near
*c. attacks	vigorous	variable (vigorous to very weak)	very weak
d. eggshells (cf. Table 1:5b)	parents remove or eat	parents remove or eat	not dispersed
2. Eggs and Chicks			
a. egg coloration	cryptic	cryptic	cryptic
b. clutch size (cf. Table 5:2a)	three	one	two
*c. plumage	cryptic brown	cryptic gray	not cryptic
*d. behavior	hides in vegetation	hides in cracks	does not hide

* See Table 6.

TABLE 5

CHARACTERISTICS PRESUMABLY RELATED TO DANGER OF FALLING OFF CLIFF

SPECIES:	TYPICAL GULLS	SWALLOW-TAILED	KITTIWAKE
Cliff danger:	(none)	some	great
1. Eggs and Chicks			
a. clutch (cf. Table 4:2b)	three	one	two
*b. nest	shallow cup of vegetation	shallow cup of stones	deep cup of vegetation
2. Chicks			
*a. stay in nest	a few days	long period	long period
*b. face toward	any direction	cliff wall	cliff wall
*c. locomotion	frequent	immobile	immobile
*d. when attacked	run	do not run	do not run
*e. flight movements	vigorous	intermediate	weak
f. "visual cliff" behavior	random choice (?)	avoid deep side	?
*g. feed from	ground and parent's bill	parent's bill	parent's throat
*h. parental feeding call	present	present	absent

* See Table 6.

(which hunts both by day and night) and the hawk *Buteo galapagoensis* probably prey on *furcatus* nests (Murphy, 1936). In fact, one of the primary selective advantages of nocturnal habits of *furcatus* may be to allow the parents to stand guard at the nest through all the daylight hours when the aerial predators abound (see Hailman, 1964c for a discussion of other possible factors). However, it is not known whether the parent's merely being at the nest actually reduces predation or not.

Table 4 compares anti-predator adaptations in typical gulls, in *furcatus* and in *tridactylus*. Reduction of the clutch size might make a nest less conspicuous to predators, thereby decreasing the probability of destruction of all the eggs (also see below). However, this possible reduction of predation would not seem, a priori, to be of such magnitude to offset the approximately 66 per cent reduction in productivity caused by fewer eggs. Table 4 indicates that not only *furcatus* (Fig. 2) but also *tridactylus* have cryptically colored eggs. Cullen (1957) considers this crypticity to be ancestral, and, although of no benefit to the Kittiwake, retained because it is of no disadvantage.

(5) *Danger of falling off the cliff.*—Most Kittiwakes nest at the very edge of a real precipice; Swallow-tailed Gulls do not, on the average, nest in such a dangerous situation, although certain individuals may (see Fig. 1). Kittiwakes prevent eggs from rolling out of the nest by making an extra deep nest cup, whereas Swallow-tails use lava stones (Fig. 2). I tried rolling eggs out of several *furcatus* nests and found it very difficult (much more so than from

the nest of *L. atricilla*, the American Laughing Gull, for instance). Gulls themselves might accidentally dislodge the egg from the nest, though possibly other natural causes do too. Curio (pers. comm.) recorded one incidence of sea breakers washing an egg from its nest. Possibly the reduction of crowding due to the small clutch size also helps prevent eggs from rolling over the ledge.

One trait not appearing in Table 5 requires comment. Cullen (1957:300) notes that the Kittiwake has "strongly developed claws and toe-musculature" compared with ground-nesting gulls. The Swallow-tailed Gull appeared to me to have strong claws as well, but no stronger than those of the Lava Gull, *L. fuliginosus*. I attributed this similarity to the fact that the latter species, although not a cliff-nester, spends its life on the rock substrate of Galapagos shores. However, I later compared a long series of specimens at the U. S. National Museum, and could find no consistent differences between species of gulls, adults or chicks. Perhaps important differences are obscured in dried skins, so further checking of claws and musculature in the field is desirable.

Emlen (pers. comm.) is attempting to do "visual-cliff" experiments (Walk and Gibson, 1961) on the Kittiwake. Emlen (1963) has already shown that newly hatched chicks of the ground-nesting Herring Gull (*L. argentatus*) may avoid the deep side of an artificial "cliff." However, his apparatus and experimental procedures are sufficiently different from the standard visual-cliff situation that a direct comparison with the usual experiments cannot be made. Cullen (1957) reports that chicks of the ground-nesting Black-headed Gull (*L. ridibundus*) placed in *tridactylus* nests wandered "blindly" off the cliff. However, Shinkman (1963) showed that newly hatched domestic chicks (*Gallus gallus*) do recognize and avoid the deep side of a visual cliff apparatus; this shows that such perceptual organization is possible in a newly hatched precocial bird.

Of the ten newly hatched chicks I tested, six chose the shallow side, one the deep, and three made no choice during the 10-minute test period. The probability that this choice is due to chance is small (binomial of $\frac{1}{7}$ is $p = 0.062$). Of the three immobile chicks, one turned and stepped onto the shallow side when pushed toward the deep; the other two refused to take a step in any direction. It is further of interest that the single "deep-choosing" chick scampered ("without looking") onto the deep side immediately upon removal of the translucent box. Thus, it seems quite likely that *furcatus* chicks (like those of *Gallus gallus*) possess depth perception at hatching.

Cullen (1957) considers that the feeding of Kittiwake chicks is adaptive to cliff-nesting. Most gull species (including *furcatus*) regurgitate food upon the ground or hold it in the bill in response to the chick's pecking at red

markings on the parental bill. (The marking is a white tip in *furcatus*, presumably an adaptation to nocturnal feeding: Hailman 1964*b*, 1964*c*.) However, Kittiwake chicks take food from the throat of the parent. Lacking red markings on the bill, the parent Kittiwake has a bright red throat, to which the chicks direct pecking-like movements when it is open (although they also peck at the yellow beak; J. M. Cullen, pers. comm.). It could be that the releaser has been moved inside the bill so that Kittiwake chicks will not be tempted to approach adults and topple over the edge of the cliff. At any rate, chicks do not need a "long distance signal" in order to find the parent, nor does the parent require a Pumping display of the chick in order to find its offspring (Cullen, 1957). Since the Swallow-tailed Gull's feeding is additionally influenced by its nocturnal timing, it is not reasonable to expect this species' throat to become white, since this would probably reflect very little light indeed. However, the *furcatus* parent does have a "feeding call" that releases the approach of the chick, as has *atricilla* (Hailman, 1964*b*) and other ground-nesting species. The Kittiwake lacks this call, presumably to prevent accidentally calling chicks over the cliff.

Since in all other adaptations relating to prevention of falling over the cliff, *furcatus* resembles *tridactylus* (see Table 5), the chick-feeding differences seem to be anomalous. I suggest that in all species bill and throat colors are also under selective pressures relating to displays between adults. I have argued elsewhere, for instance, that the position of the white bill-tip of *furcatus* in relation to the white feathers at the base of the bill indicates the displaying bird's head position in very low light intensities (Hailman, 1964*c*). Surely the throat color of all gull species is evident during displays in which the mouth is held wide open during vocalizations. It is possible, then, that the chick-feeding method is influenced by display-methods and vice versa.

DISCUSSION AND CONCLUSIONS

Multiple selective pressures.—Few characteristics are governed by only one selective pressure during evolution. Thus, the removal or eating of eggshells and the young chick's droppings might serve both to prevent fouling of the nest and to prevent discovery of the nest by predators. Tinbergen and co-workers (1962) have demonstrated by field experiments that nests with broken eggshells are found and destroyed by predators more readily than nests without shells. Fouling has not been studied experimentally. Older chicks of all species defecate out of the nest. However, Kittiwakes with little nest predation defecate on the nesting ledge, while Swallow-tailed Gulls with more predation defecate over the ledge. This difference suggests that predation is important as a selective agent in defecation habits. Also, guard-

TABLE 6

SUMMARY OF THE SWALLOW-TAILED GULL'S MORPHOLOGICAL AND BEHAVIORAL CHARACTERISTICS

Environmental conditions	Morphological/Behavioral Characteristics*		
	Like ground-nesting Gull species	Intermediate	Like or equivalent to Kittiwakes
Like Kittiwake			
reduced nesting space	4	0	6
cliff danger	2 (6)	1 (1)	5 (11)
Intermediate			
nest sites scarce	1	0	0
nest predation	4 (5)	2 (2)	0 (0)
Like Ground-Nesters			
nest materials scarce	5	0	0

* Those relatively unambiguous characters marked with an asterisk (*) in Tables 1–5. See text.

ing of the nesting ledge prior to laying may serve to protect both the site and the nesting materials from being usurped by conspecifics in Kittiwakes (see above).

The clutch size of *furcatus* might be explained by Lack's (1954) proposal that clutch size in birds is determined by the number of young that can be fed successfully, although there seem to be other factors acting as well. The essence of Cullen's (1957:289 ff) interpretation of the reduction of clutch size from three to two in the Kittiwake seems to be a special case of Lack's hypothesis: if a pair of gulls can feed only two young successfully, Kittiwakes need lay only two eggs to have the maximum clutch, while "typical" gulls must lay three since there is a high probability that at least one will die from causes other than starvation (e.g., predation) that do not affect Kittiwake chicks.

Cullen's suggestion probably could not apply to the Swallow-tailed Gull, which has many potential nest predators. Instead, two additional hypotheses were advanced for *furcatus* (above). The first, that clutch reduction makes the nest less conspicious to predators, is presumably not effective in Kittiwakes because of the lack of predation. However, I think it is unlikely as the major force in reducing clutch size in *furcatus*. The other explanation, lessening of crowding of eggs and chicks to prevent their accidental falling over the cliff, might operate in Kittiwakes as well, although Cullen does not specify this possibility.

However, still a fourth factor may be acting in the Swallow-tailed Gull, one that is a corollary of Lack's hypothesis. The breeding period of seasonally

breeding gulls coincides with the abundance of food available for the young and clutch size is expanded to utilize the food maximally. In tropical species for which food is available in moderate supply the year around, the long nocturnal trek at sea for food may severely restrict the number of chicks that can be fed successfully. Although laying but one egg, *furcatus* pairs may actually rear more than one chick per year by breeding more often than annually (Snow's recent evidence, mentioned above, indicates a 10-month cycle).

Test of Cullen's hypothesis.—With the data at hand, we are now in a position to test E. Cullen's (1957) hypothesis that the peculiarities shown by Kittiwakes are indirectly the result of selective pressures accompanying cliff-nesting habits. Given the degree of environmental similarity in Kittiwakes and Swallowtails, we can see how closely their characters match. (The following comparison omits (a) characters that cannot be evaluated as being either like Kittiwakes or ground-nesting gulls and (b) characters that cannot be assigned, a priori, to a single presumed selective pressure.)

Table 6 divides 30 characters of *L. furcatus* into a matrix of the degree of similarity with *tridactylus* versus the degree of similarity of the environmental conditions presumably related to the characters. It is evident that in those respects in which the environmental conditions (i.e., presumed selective pressures) are similar, the morphological and behavioral characters are also similar. Taken as a whole, the data constitute a clear vindication of Cullen's (1957) hypothesis that peculiarities of the Kittiwake are the result of special selective pressures that accompany cliff-nesting.

Why does the Swallow-tailed Gull in some respects resemble ground-nesting gulls when the environmental characteristics are similar to those of Kittiwakes? Several answers are possible. (a) First, *furcatus* does not experience as extreme an environment as does *tridactylus*, even in those respects where the environment is designated as "like Kittiwake" in Table 6. (For instance, Figure 1 shows that the danger of falling over the cliff is not as great.) (b) Secondly, the independent adaptation of *furcatus* to cliff-dwelling may not yet have proceeded far enough to evolve the full complement of characters possessed by *tridactylus*. That is, in evolutionary time *furcatus* may be a more recent cliff-nesting species; or *furcatus* may have some kind of genetical limitations which have not produced the variation for natural selection to work upon. (c) Lastly, other selective pressures which have escaped the notice of Cullen and me might be acting upon these characters in different ways in the two species. Very probably all of these reasons have some validity. The important thing is, I think, that *furcatus* completely lacks Kittiwake-like traits where its environment resembles that of ground-nesting gulls.

Epistemological status of comparative data concerning natural selection.—

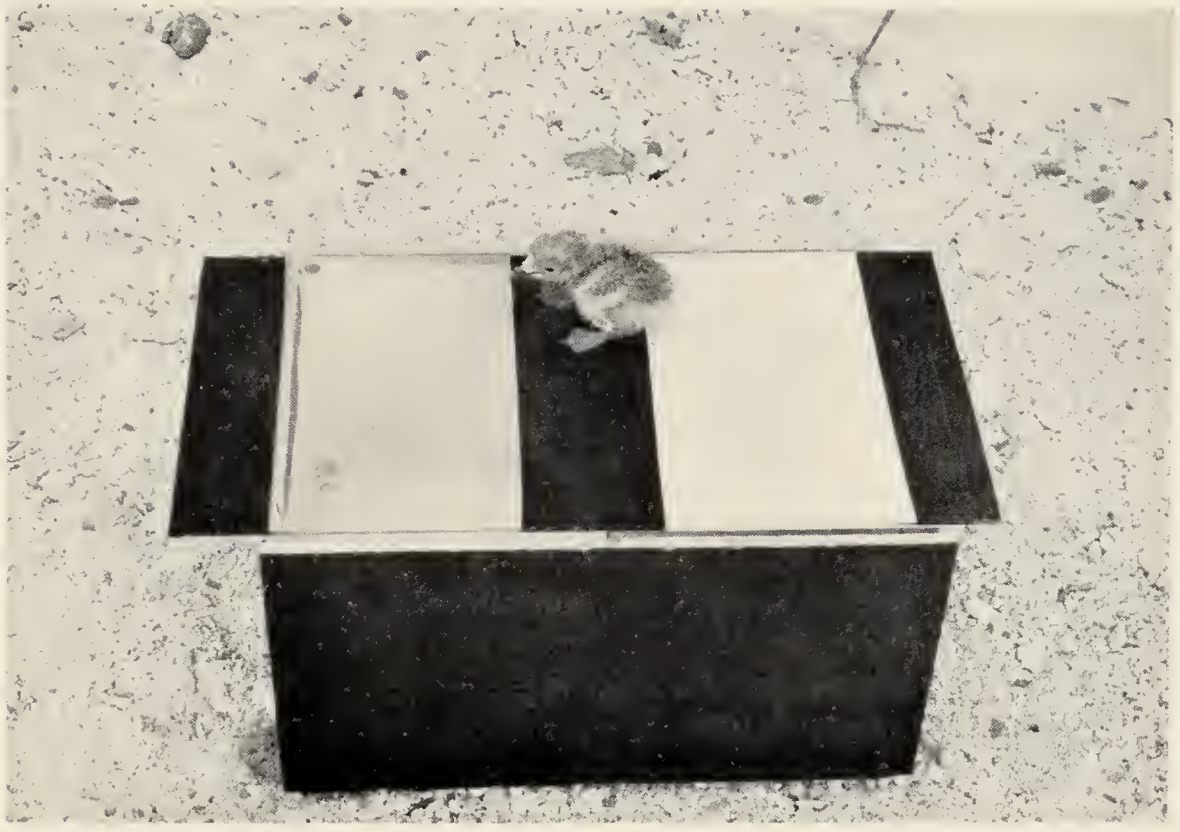

FIG. 3. A one-day-old chick of *Larus furcatus* on the visual-cliff apparatus. The chick is facing the "deep side" of the cliff. The ruled squares on the paper lining the deep and shallow sides do not show well in the photograph partly because the film used is less sensitive to blue than is the eye.

The most satisfactory method of demonstrating that a morphological or behavioral character is under the influence of a specific selective pressure is to measure that pressure within a population of organisms; deviants from the norm of the character should be more strongly selected against. For instance, Kruuk (1964) has shown that the farther a pair of Black-headed Gulls (*Larus ridibundus*) nests from the center of a colony, the heavier the nest predation by foxes.

Another method, setting up an artificial situation closely resembling the natural one, is often necessary because of the rarity of natural deviants or the difficulty of measuring deviants and differential selection in natural populations. Thus, Tinbergen et al. (1962) have shown that Black-headed Gull nests artificially set up and placed near a nesting colony will be preyed upon by both aerial and ground predators. Aerial predators find and destroy such nests more readily when broken shells are placed in or near a nest with chicks or eggs. This demonstrates rather satisfactorily at least one of the selection pressures that maintain the eggshell removal behavior of nesting adults.

Least cogent among methods of demonstrating selective pressures on specific characters is the method of this paper. A population (which may be a species. as in this case) is discovered which shows differences in morphology or behavior from other, presumably genetically related, populations. This discovery, in and of itself, is not a valid demonstration that the characters are under selective pressures due to observed environmental differences between the populations. However, this correlation does function as a *prediction* as to what characters will be found in another population with the same environment as either the deviant or the "normal" populations already known. This third population, for which the prediction was made, constitutes a valid test of the hypothesis (i.e., environment–character causation) *only* if its characters were unknown at the time of conception of the hypothesis. (Conversely. if the new population's characters were known—say from museum skins—but its environment was not, prediction of the conditions of its environment would constitute a valid method of approach.)

This indirect, "comparative" method is, however, full of methodological pitfalls. The gene pools of all populations concerned must be similar enough that the same variations would be produced for natural selection to act upon. The populations should have been isolated and living in their present environments for sufficient time for natural selection to work. Furthermore, multiple selective pressures will usually be involved, as well as selective pressures of which the investigator is unaware. There are certainly other problems as well.

In conclusion, the present method for studying natural selection has a rather low reliability. It is, however, a vast improvement over glibly assigning a "selective advantage" to a particular morphological or behavioral character just because to do so seems "reasonable" a priori.

A Postscript.—Shortly after the manuscript of this paper was finished, there appeared a study of the cliff-nesting tern, *Anous tenuirostris* (the Black Noddy). J. M. Cullen and N. P. Ashmole (1963) found many differences between this species and other terns, and these unique characters closely resemble those of the Kittiwake and the Swallow-tailed Gull. The one "new" possible cliff-nesting adaptation reported for *furcatus* (allo-preening), Cullen and Ashmole discovered in the Black Noddy as well. Their study adds a further confirmation of E. Cullen's (1957) hypothesis.

SUMMARY

The Galápagos Swallow-tailed Gull (*Larus* (*Creagrus*) *furcatus*) nests on shallow to steep cliffs. In some respects (i.e., reduced nesting space, danger of falling over cliff) its environmental conditions resemble those of the cliff-nesting Kittiwake (*L.* (*Rissa*) *tridactylus*). Unlike *tridactylus*, *furcatus* has abundant nesting materials available, as do ground-nesting gulls such as *L. argentatus* and *atricilla*. In some aspects of its ecology

(availability of nest sites, amount of nest predation) *furcatus* is intermediate between the *tridactylus* and ground-nesting gulls.

Many behavioral and morphological characteristics of *furcatus* were noted in field study and experiments. Thirty of these are unambiguous enough for comparison with the other species. Of those characters presumably adaptive to the environmental conditions shared with ground-nesting gulls, all five resembled the characters of the ground-nesting species. Of seven characters presumably related to the "intermediate" ecological conditions, five resembled characters of ground-nesters and two were intermediate. Finally, of 17 characters presumably adaptive to conditions shared with the Kittiwake, 11 resembled those of the Kittiwake, one was intermediate, and 6 resembled those of ground-nesting species.

Thus, Cullen's (1957) hypothesis that the Kittiwake's unusual characters are adaptive to special ecological conditions accompanying cliff-nesting is, in general, confirmed.

ACKNOWLEDGMENTS

The research trip to the Galapagos was sponsored by NSF Grant No. GB98 to Dr. Peter H. Klopfer. I was accompanied in the field by Jeremy J. Hateh and Robert Risebrough, who were helpful in many ways. Dr. A. Brosset, then director of the Darwin Station, was instrumental in arranging field trips in the Galapagos. Dr. George Watson of the U.S. National Museum made available the gull collections there for study of claws and toe musculature. The manuscript was improved greatly through the critical comments of J. J. Hateh, Dr. E. Curio, Dr. P. H. Klopfer, and especially Drs. J. M. and E. Cullen.

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COMPARATIVE ETHOLOGY OF THE CHESTNUT-SIDED WARBLER, YELLOW WARBLER, AND AMERICAN REDSTART

Millicent S. Ficken and Robert W. Ficken

Comparative studies are of great value in elucidating the evolution of behavior and one of the distinguishing characteristics of ethology is its emphasis on this approach (e.g. Lorenz, 1952; Tinbergen, 1959). Such research has added to our understanding of the evolution of avian communication systems, particularly displays. *Displays* have been defined by Moynihan (1955) as "those peculiarly standardized and often exaggerated performances including all vocalizations and many movements and postures which have become specialized and modified as social signals or releasers." *Ritualization* is the process by which displays evolve from nonsignal precursors and usually includes the exaggeration of movements as well as changes in the readiness to respond to these movements so that they attain a communicatory function (Blest, 1961).

The criteria for homologies in behavior are the same as in morphology when there is no fossil record. Behavior patterns are probably of common origin when they are similar in form, widespread in a group, and have similar motivations, functions, and derivations (Tinbergen, 1959). We have capitalized names of behavior patterns which are probably displays and have given displays of different species the same name on the basis of Tinbergen's criteria.

The Wood Warblers (Parulidae) are particularly favorable subjects for comparative ethological studies because they are of relatively recent origin with many closely related species, have complex visual and vocal communication systems, and have undergone adaptive radiation into a variety of habitats with consequent behavioral changes (Ficken and Ficken, 1962). The purpose of this study is to describe and compare the reproductive behavior of several species of warblers, to indicate evolutionary trends in their displays, and finally to make some taxonomic comments.

METHODS

The American Redstart (*Setophaga ruticilla*) was studied intensively and since its behavior is described in detail elsewhere (Ficken, 1962, 1963), it will be referred to mainly for comparative purposes here. Almost all observations were made in an area of high population density in Ithaca, New York (Renwick Bird Sanctuary).

Chestnut-sided Warblers (*Dendroica pensylvanica*) were investigated on a brushy hillside along the railroad tracks in Varna, New York. The popula-

tion density was locally high, with the average territories of five adjacent males about 0.2 hectare in size. Observations were concentrated on these five birds during May, 1961, with subsequent more casual notations on other individuals. Watching took place before nest building was completed.

Yellow Warblers (*Dendroica petechia*) were studied principally at Howland's Island, New York, in May, 1962, and April and May, 1963. This was very favorable habitat with many 0.1-hectare territories; competition for them was intense (Ficken and Ficken, 1965). Approximately 10 pairs were studied during the period before the completion of nest building.

In addition, we observed some behavior patterns in other species of *Dendroica* on migration and, in the case of the Myrtle Warbler (*D. coronata*), in captivity. The Black-throated Green Warbler (*D. virens*) was observed during June, 1964 on Hog Island, Lincoln Co., Maine.

Notes on all species were spoken into a small portable tape recorder.

AGONISTIC BEHAVIOR

In all three species, most males arrive a few days before the females and immediately establish territories. During the first few days there are many conflicts within zones along territorial borders. Chestnut-sided Warblers however, have *fewer actual encounters* than in the other two species, even when the males are close together in the boundary zone. They may even feed about 10 feet apart in between boundary encounters; this never occurred in the other two species. However, Chestnut-sided Warblers tend to have prolonged disputes which involve intermittent encounters in the same location over several hours. Redstarts, and, to a lesser degree, Yellow Warblers, usually have *many encounters in a short time*, after which one or both males retreat well into their territories.

The following activities occur during or following male territorial encounters:

Circling.—This display occurs in several *Dendroica*. It is apparently confined to the boundary zone, and consists of a flight toward the opponent, then a turning away before reaching him. In the Chestnut-sided Warbler it is the *least ritualized*, often a simple arc made only in the general direction of the opponent but not reaching him closely or oriented at him. There is almost never any modification of wing beats or any response from the opponent. Yellow Warblers exhibit this display in the *least stereotyped* form, from a mere unoriented arc like that of the Chestnut-sided Warbler to nearly complete circles. At times a male Circles directly at the opponent, but often he does not. Occasionally the opponent Circles in response. Black-throated Green Warblers perform very circular flights, orienting toward an opponent and returning to near the original perch. Circling is most ritualized and least

TABLE 1

COMPARISON OF FREQUENCY AND FORM OF CIRCLING DISPLAYS IN FOUR SPECIES OF WARBLERS

	Yellow	Chestnut-sided	Black-throated Green	Redstart
Frequency of display	++	+	++	++
Circularity	++	+	+++	+++
Stiff flight toward opponent	0	0	?	+++
Glide away from opponent	+	+	?	++
Approach closely to opponent	+	+	++	+++
Opponent responds by circling	+	0	++	+++
Oriented at opponent	++	+	+++	+++

? = not observed, 0 = apparently absent, + = rare, ++ = fairly common, +++ = frequent.

variable in the redstart; there is often a nearly perfect circle and the wing beats are usually modified (See Ficken, 1962; 608–609). The high degree of ritualization in the redstart, and the preceding species, is demonstrated by its signal value; the opponent usually Circling in return. Kendeigh (1945) reports Circling in the Magnolia Warbler (*D. magnolia*) although it is not as exaggerated as in the redstart. We did not observe this display in 3 years of intensive study of Blue-winged Warblers (*Vermivora pinus*) and Golden-winged Warblers (*V. chrysoptera*) and, except for the redstart, Circling has so far only been reported in *Dendroica.*

There is a graded series in the complexity of this display (Table 1). The condition in the Chestnut-sided Warbler is probably close to the primitive one. In fact, the lack of exaggeration of form and absence of an immediate response by the opponent indicate it may not be ritualized. This is also supported by its being given less frequently than in the other species. The redstart presents the advanced condition in this display in having great stereotypy and a well-defined signal function. This display probably functions as a threat (Ficken, 1962; Ficken and Ficken, 1965). It evidently expresses an attack–escape conflict in all species (Ficken, 1962).

Gliding.—This is a coasting flight with wing and tail spread wide, usually away from the opponent. Gliding is rare or fairly common in all three species during territorial encounters. It is most easily noticed in redstarts because their red wing and tail patches are maximally exposed.

Fighting.—Fighting is more ritualized in the redstart than in the other two. In fact, in this species it is often a "sham" and the birds do not strike each other. In the Yellow and Chestnut-sided Warblers the birds seem to hit each other and sometimes lock together.

Chases.—In the Chestnut-sided Warbler chases are simple and direct, while those of the redstart and Yellow Warbler are often more prolonged with many intricate turns.

Following occurs *only* in the Chestnut-sided Warbler. Unlike a chase in which the pursuer usually initiated the action, the opponent is simply followed as it flies away.

Supplanting was seen also only in the Chestnut-sided Warbler. The bird simply flies toward its opponent which then leaves and the first bird lands near where the second was perched.

Tail Spreading.—A frequent display in the redstart, it was observed several times after encounters in the Yellow Warbler and not at all in the Chestnut-sided.

Wings Out.—This posture in which the wings are held out from the body occurs in all three species after prolonged encounters. It is oriented at the opponent who usually retreats.

Moth Flight.—This display, in which the wings are beaten very rapidly and flight is slow, occurred only in the Yellow Warbler as a not infrequent part of agonistic encounters between males.

Sleeked Postures.—Preceding or, more commonly, following agonistic encounters, male redstarts often compress their feathers, giving them a very slim appearance. This is less frequent in the Yellow Warbler and was not observed at all in the Chestnut-sided Warbler.

The relative frequency of various nonvocal agonistic activities by unmated males is shown in Table 2 and other displays for which quantitative data are lacking are roughly graded according to frequency in Table 3. Fighting is about equally common in the three species. The Yellow Warbler and redstart are almost identical in the percentage of all agonistic activities. However, the Chestnut-sided Warbler differs in performing Circling less frequently and in Following and Supplanting the opponent. Many of the redstart displays reflect an attack–escape conflict (e.g., Circling, Gliding, Tail Spreading, and even Fighting). Behavior indicative of relatively strong escape tendency (e.g., Sleeked Postures) is also more common in this species. In addition, its tendency to attack an opponent also seems higher than in the other two species. Thus, the redstart expresses the *strongest attack* and *escape tendencies*, as well as the greatest conflict between these tendencies. The redstart also shows the *highest degree of ritualization of agonistic displays*. Circling is more exaggerated and has a greater signal value. Even Fighting appears ritualized. The Chestnut-sided Warbler, on the other hand, has less ritualized agonistic behavior and shows little evidence of an intense attack–escape conflict. This pattern is to be expected since displays usually express a conflict of two or more tendencies. The Yellow Warbler is intermediate in many respects.

TABLE 2

FREQUENCY OF NONVOCAL AGONISTIC BEHAVIOR OF UNMATED MALES DURING TERRITORIAL ENCOUNTERS (EXPRESSED AS PER CENT OF TOTAL)

Activity	Species		
	Yellow ($n = 49$)	Chestnut-sided ($n = 35$)	Redstart ($n = 55$)
Fighting	24	27	23
Chases	42	21	40
Following	0	9	0
Supplanting	0	27	0
Circling	33	16	37

These species-typical differences in agonistic motivations are probably a reflection of historical differences in population density. Our observations on all three species were made in areas of locally high population density. However, the Chestnut-sided Warbler, which is dependent on clearings, was apparently very rare until recently (Bent, 1953), the Yellow Warbler was probably more confined to riverbanks than it is now, while the American Redstart has probably been very common for a longer time since it occupies the forest understory. There seems to be an increase in the development of agonistic signals in these species related to the number of conspecifics against which they once had to defend territories. Chestnut-sided Warblers presumably had few conspecifics nearby. The Yellow Warbler in a riparian environment probably had males on either side. The American Redstart, on the otherhand, had three or four adjacent conspecific males. The Chestnut-sided Warbler, and probably to a lesser degree the Yellow Warbler, have increased greatly in the last century as suitable habitat became abundant. However, the territorial displays which would seemingly be useful in populations with high densities have lagged behind.

Vocalizations.—These species have a variety of vocalizations which are

TABLE 3

OCCURRENCE OF AGONISTIC DISPLAYS IN THREE WARBLER SPECIES

Activity	Species		
	Yellow	Chestnut-sided	Redstart
Sleeked Posture	+	0	+++
Wings Out	+	+	+
Gliding	+	+	+
Tail Spreading	+	0	+++
Moth Flight	++	0	0

0 = apparently absent, + = rare, ++ = fairly common, +++ = frequent.

TABLE 4

CONTEXTS OF UNACCENTED ENDING SONGS (UES), ACCENTED ENDING SONGS (AES), AND MUTED SONGS (MUES, MAES)
(EXPRESSED AS PERCENTAGE OF TOTAL SONG FOR THAT CONTEXT)

SPECIES	CONTEXT															
	Before arrival of females				Undisturbed on territory, pair formation through early nest building				Undisturbed on territory, late nest building				Following territorial encounters at boundaries			
	AES	MAES	UES	MUES	AES	MAES	UES	MUES	AES	MAES	UES	MUES	AES	MAES	UES	MUES
Chestnut-sided Warbler	95	0	5	0	91	0	9	0	24	0	24	51	3	0	83	14
	$n = 40$				$n = 69$				$n = 41$				$n = 29$			
Yellow Warbler	96	0	4	0	95	0	5	0	58	0	39	3	4	13	26	56
	$n = 82$				$n = 42$				$n = 33$				$n = 46$			
American Redstart	95	0	5	0	59	0	41	0	50	0	50	0	0	0	42	58
	$n = 102$				$n = 22$				$n = 50$				$n = 32$			

similar in form and context (Ficken and Ficken, 1962). Zeeps are commonly given during or preceding flight. Chips of two types occur in a variety of agonistic situations; these calls, harsh and metallic, at times grade into each other. Titis are rarer, occurring after prolonged territorial encounters. Females of some species of *Dendroica* as well as *Setophaga ruticilla* Snarl when the male approaches but this was not recorded in the Yellow or Chestnut-sided Warblers, perhaps because of insufficient observations. Bill Snaps frequently occur during or just preceding an attack in many warbler species. The above are the principal "call notes" of these species although there are some soft vocalizations which are infrequently heard and difficult to describe, such as the female Soliciting vocalization, certain calls between male and female at the nest, and notes of the young.

Song.—Each species has two principal song types, one with an accented ending (Accented Ending Song) and the other without this ending (Unaccented Ending Song) (Ficken and Ficken, 1962; 112–113). The types are well-defined in the redstart but the Yellow and Chestnut-sided Warblers have some intermediates with a weak ending. The contexts of these songs in the three species are shown in Table 4.

Before the arrival of females over 90 per cent of the songs of these species have Accented Endings. However, in the American Redstart Unaccented Ending Songs become about equally common with Accented Ending Songs when nest building commences, and the same shift seems to occur slightly later (during egg laying and incubation) in the other two species. By the time of hatching, Unaccented Ending Songs predominate in all three species. In addition to this seasonal change in song type there is a difference in context earlier in the season. Songs immediately following territorial encounters are more frequently Unaccented Ending Songs and muted songs. The song types following encounters vary slightly according to the species. For example, the Yellow Warbler differs from the other two in singing Muted Accented Ending Songs as well as Muted Unaccented Ending Songs under these conditions.

We have attempted to determine the motivation of these songs from their contexts. Most encounters at boundaries end in a "draw," both birds retreating from the encounter area. More rarely, there are encounters within a male's territory and the territorial male is usually the victor, i.e., the other immediately retreats. Following such encounters the victorious male in all three species gives Accented Ending Songs more commonly and the vanquished male, Unaccented Ending Songs. The vanquished male presumably has a higher escape tendency (he fled from his opponent), indicating that the Unaccented Ending Song is more closely associated with escape. Sequences of songs by a single bird following boundary encounters give additional motivational cues. An example from our field notes involves an

unmated male redstart singing all Accented Ending Songs for an hour on his territory. Then he had an encounter with another male on a boundary after which he returned to his territory. He then sang five Muted Unaccented Ending Songs, and a minute later, all Unaccented Ending Songs. Three minutes after the encounter he alternated Accented Ending and Unaccented Ending Songs. Finally, 5 minutes after the encounter he sang all Accented Ending Songs. This example shows again that when the escape tendency is strong (although both attack and escape are presumably involved during territory encounters, escape is probably stronger immediately afterwards) Unaccented Ending Songs are more common. Additional evidence for the motivation of this song is that as aggressive and sexual tendencies decrease seasonally, and escape is thus relatively stronger, songs shift to the Unaccented type.

Sexual tendencies inhibit the territorial song, since males rarely sing near the female, particularly during courtship. Apparently the typical territorial song, the Accented Ending Song, occurs when there are no specific stimuli releasing strong aggression, escape, or sex. If sex or aggression is particularly strong, the birds are usually silent. If the escape tendency is high, they sing Unaccented Ending Songs or mute their songs.

Evidence for the function of these songs is more difficult to obtain. However, we do have some observational evidence that the Accented Ending Song is more attractive to conspecific females than the other song. In all cases we studied birds on adjacent territories which were similar in size and vegetational composition, in order to minimize these influences on the female's selection of a mate. One year we studied five unmated Chestnut-sided males on adjacent territories. Four sang all Accented Ending Songs, as would be expected at this time but the fifth was unusual in that he sang only Unaccented Ending Songs from the time of his arrival. This bird was the only one that failed to obtain a mate. In addition he was less successful in defending his territory boundaries against intrusions by other males. In another case a male redstart sang only Unaccented Ending Songs. When compared to five males on adjacent territories he was the last to obtain a female. Also, when compared to 15 other males he was the least aggressive and was unusual in that he tolerated the advances of other males into his territory. These observations suggest that Accented Ending Songs are more attractive to females than Unaccented Ending Songs and support further their motivational basis.

Related to its function in attracting a female, Accented Ending Songs seem to function in maintaining reproductive isolation. They are more species typical than the Unaccented Ending Songs which are sung more frequently after pair formation. Another bit of evidence of this function is that West Indian Yellow Warblers with fewer sympatric congeners, have songs that "resemble the more nondescript ones of North American forms but are oc-

casionally more melodious" (Bond in Griscom and Sprunt, 1957; 264). In Puerto Rico the resident Yellow Warblers sing only the Unaccented Ending Song (Francis G. Scheider, pers. comm.). This is also true in Cozumel, Yucatan, and Costa Rica, where this song is also more variable than in the northeastern United States (Douglass Morse, pers. comm.).

A study of these songs gives additional evolutionary insights. The context in which Accented Ending Songs are given is slightly different in the three species studied, probably reflecting slight threshold differences, a common evolutionary trend. Threshold differences usually precede grosser changes in the form of a display and are often one of the first steps in the divergence of a display in closely related species (Hinde, 1959). The Unaccented Ending Song is probably the more primitive one since it is similar in several *Dendroica* species (Ficken and Ficken, 1962; 112).

COURTSHIP

Relations between members of a pair were studied intensively only in the redstart (Ficken, 1963), but the general pattern of sexual activity seems similar in the Chestnut-sided and Yellow Warblers. The male is initially aggressive toward the female. His aggression decreases gradually and his sexual tendency increases during nest building. Various displays are given during nest building and the day or two after the nest is completed. Copulation, at least in the redstart, occurs a day or two before the first egg is laid and then courtship activities cease.

Female courtship displays.—The female Soliciting posture is similar in many passerines, consisting of crouched body, vibrating wings. and often a low volume vocalization. Soliciting is similar in the redstart and Yellow Warblers, but was not observed in the Chestnut-sided Warbler. Females of all three species give Chips and Zeeps (Ficken, 1963) which probably keep the male aware of the female's presence and location.

Male courtship displays.—In the redstart male courtship displays are highly variable, including a varied combination of components (Ficken. 1963). Since only a few instances of courtship displays were recorded for the other two species. there is by no means a complete inventory.

Male redstarts and Chestnut-sided Warblers frequently Glide when flying away from the female. Moth flight occurs in the same context in the Yellow Warbler.

Fluffed displays, in which the body plumage is fluffed and the rump feathers ruffled, occur during early nest building in the Chestnut-sided Warbler and the redstart and are apparently identical. There were fewer observations of Yellow Warblers during this period and this display was not observed. Certain courtship displays occurring during late nest building, and apparently

reflecting an increased sexual tendency, were similar in the three species. The male approached the female within a foot with his wings extended horizontally. In the redstart the feathers were also fluffed. Kendeigh (1945) describes a slightly different version in the Chestnut-sided Warbler in which "The tail feathers are spread, the wings extended, and the crown feathers erected. The wings and tail quiver up and down."

Courtship displays of other species of *Dendroica* also include fluffing the plumage (including crown raising) and moving the wings in various ways (extending, spreading, vibrating) (Ficken and Ficken, 1962; 115). Although courtship displays are often divergent in closely related species (Hinde, 1959), distinctiveness is probably achieved in this group of closely related species by the differences in color and pattern exhibited by the displays. Another reason that these courtship displays do not show greater specific distinctiveness (Marler, 1957) is that they are not involved in pair formation. Therefore, other displays, primarily song, have greater specific distinctiveness in this group.

TAXONOMIC CONCLUSIONS

The redstart is remarkably similar in behavior to members of the genus *Dendroica*. In some cases the difference between the agonistic behavior of *D. petechia* and *D. pensylvanica* are greater than those between *D. petechia* and *Setophaga ruticilla*. A comparison of the behavior patterns of several *Dendroica* species (some species were observed for only a short time and only a few activities were noted), *Setophaga ruticilla*, and two *Vermivora* species is given in Table 5. The redstart shares 14 displays with *Dendroica* but only four of these with *V. chrysoptera* and *V. pinus*. Many of these shared behavior patterns are evolutionarily improbable (e.g., the possession of two song types differing primarily in the ending and occurring in similar contexts). This, combined with the number of shared displays, makes close relationship of the species involved highly probable.

Male redstarts do not attain fully adult breeding plumage until their second year, differing in this respect from other members of the family except the Olive Warbler, *Peucedramus taeniatus* (Webster, 1958). However, closely related species of other groups, e.g., Orchard and Baltimore Orioles (*Icterus spurius* and *I. galbula*) differ from each other in this respect and therefore, it does not seem a valid basis for generic separation of the redstart and *Dendroica*.

The genus *Setophaga*, including only the American Redstart (*S. ruticilla*) and the Painted Redstart (*S. picta*), was characterized by Ridgway (1902) on the basis of features such as the shape of the bill and the condition of the rictal bristles. Such characters were given great weight in the classical tax-

TABLE 5

COMPARISON OF BEHAVIOR OF WARBLERS OF DIFFERENT GENERA

Activity	*Dendroica*[1]	*Setophaga ruticilla*	*Vermivora chyroptera and V. pinus*[2]
Vocal			
Harsh and Metallic Chips	×	×	0
Zeep	×	×	0
Titis	×	×	0
Snarl	×	×	0
Bill Snap	×	×	×
Unaccented Ending and Accented Ending Song	×	×	0
Nonvocal Agonistic			
Tail Spreading	×	×	×
Wings Out	×	×	0
Circling	×	×	0
Head Forward with Gape	×	×	×
Gliding	×	×	0
Moth Flight	×	0	×
Courtship			
Fluffed display	×	×	0
Male display with wings extended	×	×	0
Female Soliciting with vocalization	×	×	0

× = present (in the case of *Dendroica* in at least some species.
0 = not observed and apparently absent.

[1] Species studied include *D. petechia, D. pensylvanica, D. virens, D. magnolia, D. coronata, D. cerulea, D. fusca.*
[2] Ficken and Ficken, M.S.

onomy of the warblers. However, Parkes (1961) presented morphological evidence for the relationship of *S. ruticilla* to *Dendroica* and pointed out that the similarity of *S. picta* and *S. ruticilla* is probably the result of similar feeding habits and not indicative of close relationship. He concluded that *S. ruticilla* should be in a monotypic genus but placed near *Dendroica.* On the other hand *S. picta* shows affinities with the Central American redstarts of the genus *Myioborus* (Parkes, 1961; Ficken, 1965). More recently Phillips, Marshall, and Monson (1964) suggested that both *S. ruticilla* and *S. picta* should be included in the same genus as *Myioborus.* However, they apparently agree with Parkes and state that *S. ruticilla* has a "*Dendroica*-like song, eggs and tree nesting" and is therefore an "odd ball" in their proposed classification. The logic for their proposal is that "within *Dendroica* there is much diversity, and perhaps some should be allowed in *Setophaga* unless we are to 'split'." We think that both "splitting" and "lumping" are called for and that *Setophaga ruticilla* and *Dendroica* should be combined in the same genus and *S. picta* placed with *Myioborus.*

SUMMARY

The agonistic displays of the three species are described and related to differences in motivation which probably evolved through different selective pressures resulting from different historical population densities. The motivation, function, and evolution of song in this group are discussed. The species share similar song types, call notes, courtship, and agonistic displays. It is concluded that *Setophaga ruticilla* and *Dendroica* should be placed in the same genus.

ACKNOWLEDGMENTS

This work was supported by a National Science Foundation Grant (GB-891) and a Chapman Memorial Fund Grant. We wish to thank Dr. John F. Eisenberg and Dr. Douglass Morse for their criticisms of the manuscript.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND, 13 JANUARY 1965

NEW LIFE MEMBER

Judith (Mrs. Bernard) Lewin, of Cote St. Loc, Montreal, Quebec has recently become a Life Member of the Wilson Ornithological Society. A housewife and mother of a small daughter, Mrs. Lewin finds time to devote to the study of local birds. Among her other interests is sculpture, and she would like to combine the two by doing bird sculpture. She and her husband have also been interested in bird photography. Besides the Wilson Society, Mrs. Lewin is a member of the Canadian Audubon Society, The Massachusetts Audubon Society, the Ontario Federation of Naturalists, and The Province of Quebec Society for Protection of Birds.

BEHAVIORAL ASPECTS OF HABITAT SELECTION: A PRELIMINARY REPORT ON STEREOTYPY IN FOLIAGE PREFERENCES OF BIRDS

Peter H. Klopfer

We previously advanced the view that the great faunal diversity of tropical regions is due largely to a stereotypy in behavior that is characteristic of tropical species. In essence, we proposed that tropical animals are "masters-of-one-trade," in contrast to the "jacks-of-all-trades" that we believe occupy temperate regions. A community of "masters-of-one-trade," of specialists, should be able to accommodate many more different kinds of animals, even while the number of individuals of each kind must be reduced (Hutchinson, 1959). Our preliminary observations supported this contention (Klopfer, 1962; and Klopfer and Hailman, 1965) although we were never able to provide more than indirect and inconclusive evidence. One major problem has been the actual measurement of "behavioral stereotypy."

The term behavioral stereotypy was intended to refer to both perceptual and motor stereotypy. Perceptual stereotypy involves a sensitivity to, or an awareness of, or preference for, a limited range of a much larger complex of stimuli. An animal that responds only to a narrow band of wavelengths, for example, would be considered perceptually more stereotyped than one responding to a wider band. It should be noted that stereotypy can thus be due either to filters in the peripheral sensory field, which, for instance, transmit only wavelengths of a given value, or to central nervous mechanisms. These last may be of many different types, but their nature, although of evolutionary importance, need not concern us here.

Motor stereotypy refers to the availability of only a small variety of movements by means of which an animal can accomplish a given act. Here, too, the constraints may be peripheral, in terms of muscle attachments, of limb shapes, or central. The precise nature of these constraints is also tangential to the purpose of this inquiry (cf. Klopfer, 1962). Both motor and perceptual stereotypy, may also be a phenotypic or a genotypic characteristic. Gause (1942) has provided an enlightening discussion of the apparent inverse relation between the flexibility of soma and germ plasm, a theme more recently developed by Bateson (1963). I return to this facet of the problem in the discussion of the data.

We have begun our study of behavioral stereotypy by examining *preferences* for particular types of foliage in tropical and temperate zone birds, under conditions where leaf shape, size, or leaf density were the only variables. Our most recent results are given below. It will be apparent that we have

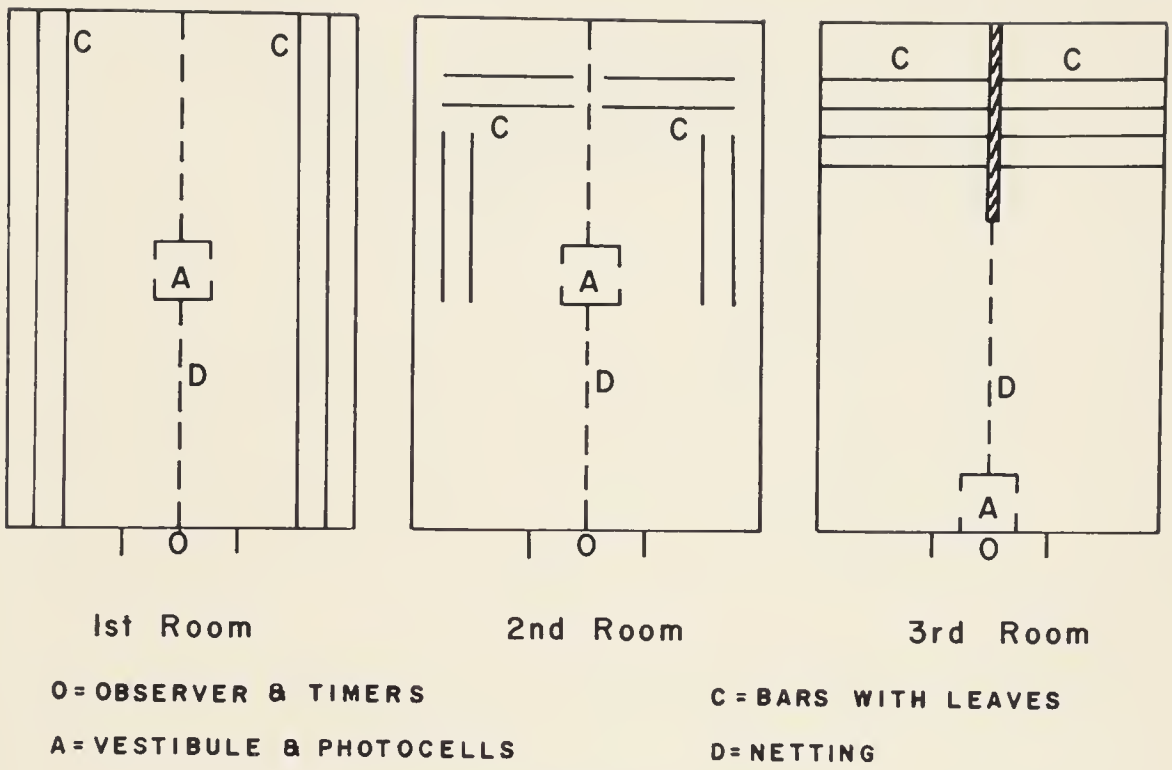

FIG. 1. Floorplan of test chambers.

yet to demonstrate a link between perceptual stereotypy, as measured by preference tests of the sort described below, and motor stereotypy. For the present time, we merely assume that there is such a correlation, leaving an empirical test to the future.

METHODS

The three test rooms averaged about 3 m × 3 m × 4 m, along the length of which a light gradient was established by means of an array of daylight fluorescent bulbs which were lit continuously for 24 hours of each day. (It may be noted that preliminary trials with a 12-hour day showed identical results.)

Along two sides of the room were arrayed horizontal, parallel, 1 cm diameter bars spaced about 20 cm above one another (Fig. 1). These bars provided an abundance of perches of uniform position and size. To these bars were tied the test leaves, a different type on the bars of each side. Some leaves were also placed directly against the wall and hung from the ceiling. The purpose of tying leaves to the racks was to assure that equal perch opportunities would be provided among both foliage types, a fact which is of course not the case in nature where the difference in the perch opportunities afforded by e.g., a broadleaf tree and a pine is rather great. (Klopfer, 1963). The leaves themselves were commercially made of a glossy green plastic. The following were used with their maximum lengths indicated: large oak: 24 cm, small oak: 14 cm, large elm: 14 cm, and small elm: 8 cm.

Altogether, 3 different chambers were used for each bird (Fig. 1) so as to eliminate totally position or other effects. The test with foliage pairs was replicated in different

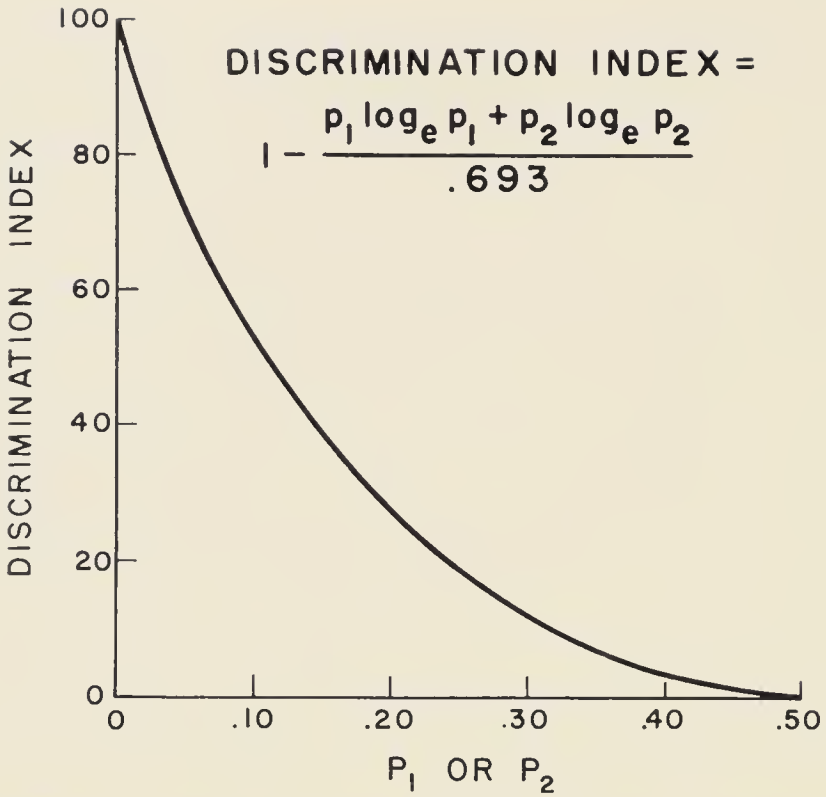

FIG. 2. Mathematical relation between discrimination index (H) and per cent preference for any given member of a pair of discriminanda.

rooms. In two of the chambers a partition was arranged so the bird could see both foliage types whereever it perched. In the third chamber, a bird perching amidst one foliage type could not see the other.

The rooms were divided into the two equal and symmetrical chambers by means of 0.4-cm netting. Passage from one section to the other was only possible through an approximately 20 cm × 20 cm × 20 cm "vestibule," within which food was provided ad libitum. Passage to and from the vestibule was monitored by a series of paired photo cells which automatically recorded the duration of visits to one side of the chamber or the other. The measure of a preference was the proportion of a three- to five-day period spent in one or the other side, following a 24-hour habituation period.

The four foliage types were offered in all possible pairs, although, because of escapes or mortality, every bird was not tested with every pair. For each pair of foliage types, the proportion of time spent amidst one or the other type was calculated and a "discrimination index" read from the graph (Fig. 2).

The graph represents a form (modified by R. H. MacArthur) of the now commonly used expression $\Sigma\ p_i\ (-\log_e\ p_i)$ (cf. MacArthur and MacArthur, 1961). The rationale for its use can be summarized as follows: the more stereotyped the preferences of an organism, the more marked will be the preferences among an array of discriminanda. If the discriminanda are paired, a completely plastic (nonstereotyped) individual should select each member of each pair 50 per cent of the time, i.e., evidence no preference. A

TABLE 1

DISCRIMINATION INDICES OF BIRDS TESTED WITH ARTIFICIAL FOLIAGE

Species	Rearing conditions	Individual values of H, based on 3 or more trials	Mean H
Thraupis cana (Blue Tanager)	hand-reared, without sight of foliage	0.06;0.09	0.08
	with pine needles	0.12;0.28;0.31; (0.08) *	0.24
Ramphocelus dimidiatus (Crimson-backed Tanager)	hand-reared without sight of foliage	0.08;0.14;0.28	0.17
Spizella passerina (Chipping Sparrow)	hand-reared without sight of foliage	0.13;0.19;0.32	0.21
		(0.08;0.13;0.13;0.13;0.13; 0.30;0.30;0.38) *	(0.19)

* Trials with less than 3 or more pairs of foliage.

highly stereotyped individual will tend to select one member of many pairs to the exclusion of the other. The greater the stereotypy, the higher the proportion of pairs for which the choice should deviate from 50 per cent. In essence, the index may be thought of as representing the proportion of choices that deviates from 50 per cent. (A similar method for assessing preferences has been employed by J. P. Hailman [In press], in multichoice situations.) The more discriminating the bird, the larger the index. Of course, if a bird selects its habitat using *one* clue only (e.g., light intensity) it would be very stereotyped but not be so labeled on the basis of tests with many (irrelevant) discriminanda. We deem this possibility unlikely in birds although it cannot be ignored. Some behavioral evidence for believing leaf shape and size to be relevant are reported in Klopfer (1963).

DATA AND DISCUSSION

The data are summarized in Tables 1 and 2. The unequal (and small) number of birds in each group is attributable to the high mortality initially encountered in efforts to hand-rear birds under unnatural conditions. (In addition, we had our fair share of escapes and human blunders.) As this work progresses, we expect sufficient data to allow use of statistical tests of significance. This point is still several seasons distant, hence the comments that follow must necessarily refer to apparent differences in group scores.

First of all, one may note that the discrimination indices for Chipping Sparrows (*Spizella passerina*) are similar whether the animals are wild-trapped adults (normally reared), or hand-reared without sight of foliage. Rearing Chipping Sparrows in the less-preferred oak foliage reduces the value of the index by a large amount (from 0.35 or 0.37 to 0.10), i.e., the birds

TABLE 2

DISCRIMINATION INDICES OF BIRDS TESTED WITH NATURAL FOLIAGE

Species	Rearing conditions	Individual values of H, based on single trials (data from Klopfer, 1963)	Mean H
Spizella passerina (Chipping Sparrow)	wild-trapped adults	0;0;0;0.3;0.5;0.5;0.5;0.5; 0.7;0.17	0.37
	hand-reared		
	without sight of foliage	0.05;0.06;0.3;0.5;0.5;0.7	0.35
	with oak leaves	0;0;0;0.1;0.1;0.2;0.2;0.2	0.10
Zonotrichia albicolis (White-throated Sparrow)	wild-trapped adults	0;0.04;0.04;0.2;0.2;0.2;0.2; 0.5;0.5;0.7	0.25

become less discriminating. This accords with the interpretation previously given (Klopfer and Hailman, 1965).

Secondly, the indices of the hand-reared Blue Tanagers (*Thraupis cana*) are apparently raised (from 0.08 to 0.24) by rearing in a particular type of foliage.

Finally, of the birds raised without sight of foliage, the Chipping Sparrows have generally higher scores than any of the tanagers (means of 0.21 or 0.35 to 0.08 or 0.17).

This suggests that the hand-reared sparrows appear to evince more stereotyped preferences than the hand-reared tanagers. On the other hand, the early visual experience with a particular foliage type appears to be much more of a constraint for the tanagers than the sparrows. Under natural conditions, of course, visual experience is not denied either young tanagers or young sparrows. Whatever the absolute differences in the range of preferences, it appears that a particular visual experience may limit the tanagers to a much greater degree than it does the sparrows. This constitutes a difference, not so much in the stereotypy of perceptual preferences themselves, but one secondarily imposed by differences in learning mechanisms.

CONCLUSIONS

Our data suggest that among hand-reared foliage-deprived birds, the Chipping Sparrows are more stereotyped in their visual preferences than are the tanagers. On the other hand, a particular visual experience serves to constrain the tanagers, but not the Chipping Sparrows. The tropical tanagers, as a consequence, can under normal conditions of rearing be expected to show a greater degree of stereotypy than the Chipping Sparrows. These experiments are continuing.

ACKNOWLEDGMENTS

The data presented here were collected during 1963 and 1964 with the support of NIH Grant No. 04453. I appreciate the assistance of James Potter, the critique of Jeremy

Hatch, and as always, the inspiration of R. H. MacArthur. The tanagers came from Barro Colorado Island through the courtesy of Martin Moynihan, to whom my thanks are tendered.

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BEHAVIOR OF THE TUFTED TITMOUSE BEFORE AND DURING THE NESTING SEASON

George C. Offutt

Except for the work of Laskey (1957) there is a lack of detailed life history information on the Tufted Titmouse (*Parus bicolor*). The present study includes new data on acoustic signals, general feeding, courtship feeding, copulation, and territoriality. Information was obtained from 25 March 1964, after the pairs had formed, until 22 May about the middle of the incubation period. Three pairs and several unmated males were observed from 1.3 to 5.5 hours per day on a random schedule in a dry deciduous woods in College Park, Maryland. Most birds were marked with strips of colored plastic about 1.5 inches long attached to their legs. Calls were recorded with a Uher model 4000-S tape recorder and a Electro-Voice model 644 (sound spot) microphone and the analysis was made with a Sonagraph Model Recorder.

ACOUSTIC SIGNALS

The calls of the titmouse can be divided into two groups, i.e., those with low frequencies between 2.0 and 2.7 kc and those with high-frequency components up to 9.5 kc (Fig. 1). During this study the females never produced low frequency calls except once just after being banded and released. Later in the season, when feeding the young in the nest, the female gave low frequency calls but they were lower in intensity than similar calls of the male.

The low frequency calls, with one exception, seem to be associated with all behaviors in approximately the same proportion. The one exception, Type B, was always given (one questionable instance) when feeding (Table 1). This call is probably the "*wheedleoh*" mentioned by Bent (1946). Therefore all other low frequency calls have been included under Type A call (Fig. 1). Although some slight variations are found, each kind of Type A call is constant in basic frequency pattern and time intervals. Several of them have low amplitude harmonics which have been assumed to have no function and are not shown in Figure 1.

The three calls (Type C, Chip and Squawk) which have high frequency components were usually associated with aggressive behavior. Type C was often followed by a series of Squawks. There may have been more than one type of Chip (Table 1). Those Chips associated with aggression were louder than those given at other times. These often were not heard unless one was close to the bird. The instances when Type C calls were emitted during other behaviors (Table 1) may have been influenced by my presence, but this did not seem to be the case.

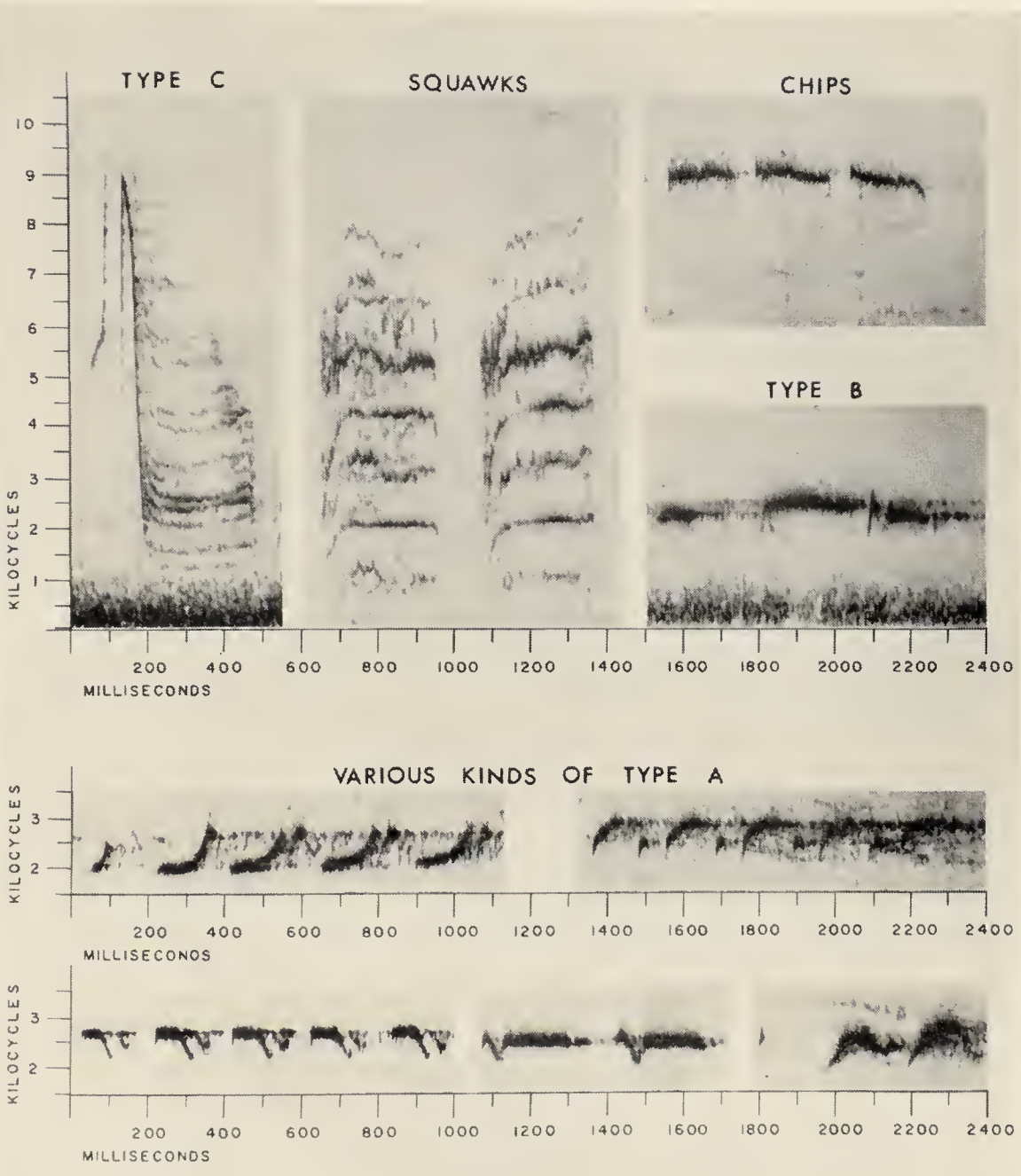

FIG. 1. Sonograms of the calls of the Tufted Titmouse.

FEEDING

The titmice occasionally fed at the end of a branch or on the trunk of the trees, but spent most of their time feeding along the branches between these two extremes. As the nesting season approached, the unmated males behaved very much as before, but the paired birds began to spend more time feeding closer to the ground (below 15 feet). They foraged on the ground

Table 1

Behavior Associated with Various Calls and Their Frequency of Occurrence

Behavior	Sex of bird	Types of Calls*				
		A	B	C	Chips	Squawks
Feeding	M	34	11	2	3	0
	F	0	0	0	0	0
Moving	M	3	0	1?	4	0
	F	0	0	0	8	0
Perched	M	6	0	0	1?	0
	F	0	0	0	0	0
Aggression toward observer	M	11	1?	6	2	3
	F	0	0	0	1	2
Aggression toward Titmice	M	18	0	10	8	6
	F	0	0	1	0	1
Pair interacting	M	4	0	0	3	0
	F	0	0	0	4	0
Male near nest	M	12	0	1	1	0

* See Figure 1 for sonograms of these calls.

and after finding food, ate it in the branches above the ground. When disturbed they emitted Chips or other aggressive calls and then flew to higher branches where Type A calls were produced by the male. On occasion, they would fly lower than 15 feet to a distant area while emitting Chips. Normally, when feeding close to the ground, they were quiet but on three occasions Chips were heard.

COURTSHIP FEEDING

Courtship feeding is the term used when the male feeds the female. As the male titmouse approached with food, the female usually began to vibrate her wings in a vertical direction close to her body (Laskey, 1957; Brackbill, 1949). Chips were sometimes emitted. The female usually continued the wing vibration during and sometimes after being fed.

Courtship feeding was first observed on 15 April which was the same day that nest building was first seen. Earlier the pair had come close together in a similar manner, but apparently no feeding occurred and the female did not vibrate her wings. As nest building continued, the number of feedings increased (Table 2). Before incubation had begun, six feedings were observed in 6 minutes. Three feedings occurred in close succession, and after the first feeding they appeared to be ritualistic, with no food being passed. The amount of feeding remained high through the incubation period.

TABLE 2

NUMBER OF COURTSHIP FEEDINGS BY TITMICE DURING THE BREEDING SEASON

Date	Stage of breeding	Number of feedings*	Hours of observation
25 March to 14 April	Before nest building	0.00	21.0
15 April to 19 April	Early nest building	0.41	14.5
20 April to 24 April	Late nest building	1.81	7.8
25 April to 2 May	Incubation	2.45	6.1

* Expressed in number of observations per hour of study.

COPULATION

Copulation was observed once at 12:30 PM on 18 April. The female emerged from the nest hole after nest building and flew toward the male who had been perched quietly 10 feet away. He moved a few feet and the female approached him twice more. After 20 seconds she began to vibrate her wings. This was apparently the same wing movement as was made during courtship feeding. After 16 seconds the male vibrated his wings for a couple of seconds and copulation occurred. No calls were heard as the distance from the observer was too great.

After incubation had started, mounting without copulation was observed in another pair at 7:00 AM on 2 May. The female had been off the nest for 3 minutes, had been fed twice by the male, and had also foraged for herself. The male approached and she began to vibrate her wings. She was fed but continued to vibrate her wings. She was immediately fed again (probably ritualistic) and continued to vibrate her wings. The male then mounted her, but did not copulate. During this time there were many Chips given, but the individual emitting them was unidentified.

TERRITORIES

The territory appeared to extend from about 15 feet above the ground to the treetops. Males infrequently sang below this height and almost all observed conflicts started above this level. An exception was noted when the intruder was close to the area of the nest, and here the territory probably extended to the ground. Most striking was the fact that the pair or unmated males went beyond their territory and under their neighbor's territory to feed for an extended time without incident. Perhaps this was possible because the neighbor did not know of the interloper's presence, as no calls except low Chips were emitted. or perhaps they were not in the other bird's territory but below it.

Before nesting, the defense of territory consisted mainly of vocal duels

TABLE 3

NUMBER OF CONFLICTS BETWEEN TITMICE DURING THE BREEDING SEASON

Stage of breeding	Types of conflicts*			
	Verbal	Circular	Contact	Wings vibrating
8–34 Days before nest building	0.37	0.07	0.00	0.00
7–0 Days before nest building	0.27	0.27	0.00	0.13
Nest building	0.09	0.04	0.04	0.22
Incubation	0.00	0.00	0.33	0.17
Total times observed	9	4	3	7**

* Expressed in number of observations per hour of study.
** Instances were noted when the ensuing conflict was not observed.

(Table 3) where the frequency of calling increased from the common 14 calls per minute to as many as 25 calls per minute. These were the same Type A calls that were given at other times (Table 1) and the individuals sometimes continued their search for food almost as before.

As the nesting season approached rival males sometimes came to within 2 or 3 feet of one another. High frequency calls were then rapidly uttered, and the birds flew in short rapid arcs around one another while keeping their distance (circular conflicts).

Later in the season physical contacts were observed. Once two males, with feet interlocked and wings beating vigorously, fell about 20 feet to the ground (see Bent, 1946). These conflicts and the circular ones were often preceded by one of the males crouching close to the branch with his body horizontal, vibrating his wings vigorously close to the body, and emitting Chips. The position was similar to that of the female during courtship feeding, but the female was more upright. A short time later, a few seconds to a few minutes, the male would fly quickly, without any undulations, toward his opponent. A conflict would then ensue or they would separate immediately.

DISCUSSION

As the breeding season approached, the unmated males behaved very much as before, but there was a marked change in the behavior of the paired birds. This was most discernible in the increased time which the pair spent feeding close to the ground. During the nesting season the females also ceased to give low frequency calls and the intensity of territorial conflicts increased.

The home range apparently extended below the neighboring bird's territory which appeared to occur from a height of about 15 feet to the treetops. Gibb (1956) states that the "territories of different *Parus* species overlap," but perhaps one could better picture the territory of the Tufted Titmouse as

a block of space situated upon a wider but thinner block, which is the home range. When the birds were in their home range, whether under their own or their neighbor's territory, there was almost no calling. This lack of calling may possibly explain the apparent disappearance of these birds after the start of nesting (Gillespie, 1930).

SUMMARY

Three pairs and several unmated male Tufted Titmice were marked and studied during a period from before nest building until after incubation had begun.

The most commonly heard calls are in the frequency range of 2.0 to 2.7 kc and are associated with most behavioral situations. Calls with frequencies up to 9.5 kc were usually associated with aggressive behavior. During the study, females did not give low frequency calls under normal circumstances.

During nesting and incubation, the paired birds spent most of their time feeding close to or upon the ground and not high in the trees as was the case before this period.

The amount of courtship feeding also increased during the nesting period and appeared to be ritualistic at times. The behavior of the female during courtship feeding may stimulate the male to mount her.

The territories appeared to be stratified with the home range below and extending beyond the territory and under the neighbor's territory. During the study period the main communication between males during defense of the territory changed from vocal interchanges to physical contact.

ACKNOWLEDGMENTS

I wish to extend many thanks to Drs. Robert W. Ficken, Millicent S. Ficken, and Howard E. Winn for their helpful suggestions, critical reading of the manuscript, and use of equipment (supplied by NSF Grant GB-891 and General Research Board U. of Md. grant to Dr. R. W. Ficken, Sigma Xi grant to Dr. M. S. Ficken; and U.S.P.H.S. NB-03241 and ONR Contract 104-489 to Dr. H. E. Winn).

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METABOLISM AND SURVIVAL TIME OF GROUPED STARLINGS AT VARIOUS TEMPERATURES[1]

Fred J. Brenner

To clarify the physiological and behavioral adaptations of Starlings (*Sturnus vulgaris*), the metabolic rates and survival times in roosting and active states of single, paired, and groups of four birds at an ambient temperature of 24–30 C and at 2–4 C were determined.

PROCEDURE

The respiration chamber used to determine the metabolic rates was an open circuit system modified from Haldane (1892), and described in a previous paper (Brenner and Malin, 1965). The chamber used for measuring roosting metabolism was a black, one-gallon, wide-mouth jar. The respiration chamber for measurement of the active metabolism was constructed from a 12-gallon rectangular aquarium covered with heavy plastic and sealed with one-inch adhesive tape.

The metabolic rates of birds in a roosting and active state at 24–30 C were determined only for single birds. At 2–4 C the metabolic rate was determined for a single bird in an active state and the roosting metabolic rates were determined for a single, paired, and a group of four birds.

The birds fasted for 3 hours at the designated temperature, in light for metabolism of active birds and in dark for metabolism of roosting birds. The birds were tested in the respiration chamber for 3 hours; after which they were removed from the chamber and immediately weighed to the nearest milligram.

The body (cloacal) and surface temperatures were recorded at the beginning and end of each test using a Yellow Springs Instrument telethermometer thermistor unit (accuracy ± 0.5 C). Probe model 402 was used to determine the body temperature and a surface probe model 408 was used for the determination of the surface temperature. The mean surface temperature was derived from six surface readings taken from different areas of the body. The birds had been exposed to the environmental temperature for 3 hours before the first temperatures were recorded and for 6 hours before the final temperatures were taken.

To determine survival time under these conditions birds were deprived of food and water until death. The birds were checked every 4 hours until midnight and then again at 8:00 AM the following morning, and the hour

[1] Authorized for publication on May 27, 1963 as paper No. 2787 in the journal series of the Pennsylvania Agricultural Experiment Station.

that the birds were found dead was recorded. Four birds were fasted to death at 24–30 C in a roosting state and four birds were fasted to death under each of the following conditions at 2–4 C: roosting singly, in pairs, and in a group of four birds.

The metabolism of roosting birds may be the basal metabolism for a bird; but the birds may not be at complete rest during the fasting period and in the chamber and so "roosting metabolism" is used throughout this paper in place of "basal metabolism."

RESULTS

The mean metabolic rate for 12 birds roosting singly at temperatures between 24 and 30 C was 2.86 ± 0.156 cc O_2/g–hr and was significantly lower than the mean metabolic rate of 4.92 ± 0.774 cc O_2/g–hr for 12 single, active birds at the same temperature ($P < 0.01$) (Table 1). A mean metabolic rate of 5.83 ± 1.20 cc O_2/g–hr was determined for 15 birds roosting singly at 2–4 C. The mean metabolic rate for 10 single birds in the chamber for measuring active metabolism at 2–4 C was 5.82 ± 0.709 cc O_2/g–hr and was not statistically different from that of birds roosting singly at 2–4 C, indicating that the birds were probably really in a roosting state in the chamber. The metabolic rate for an active bird at the ambient temperature of 24–30 C did not differ statistically from that of a single bird in the chamber for measuring active metabolism at 2–4 C ($P > 0.30$).

When roosting birds were paired in the chamber the metabolic rate decreased to 3.06 ± 0.63 cc O_2/g–hr and was significantly lower than the metabolic rate for a single bird at 2–4 C. Similarly the metabolic rate of 3.04 ± 1.39 cc O_2/g–hr for a group of four birds roosting at 2–4 C was significantly lower than the metabolic rate of a bird roosting singly at 2–4 C but was not different from the metabolic rate for birds roosting in pairs ($P > 0.90$).

The metabolic rates for birds roosting in pairs at 2–4 C was not statistically different from the metabolic rate for birds roosting singly at 24–30 C ($P > 0.70$). Similarly the rate for birds roosting in a group of four at 2–4 C was not statistically different from the metabolic rate of a bird roosting singly at 24–30 C ($P > 0.75$).

The body and surface temperature decreased for single and paired birds after 6 hours of exposure to an environmental temperature of 2–4 C. The mean body temperature of 15 birds roosting singly at 2–4 C was 39.8 C and the mean surface temperature was 31.7 C which represent a 2.7 degree decrease in body temperature and a 5.7 degrec decrease in surface temperature from the birds roosting singly at 24–30 C (Table 1). The mean decrease in body temperature of birds in pairs (total of 24 birds) in the chamber was

TABLE 1

AVERAGE BODY WEIGHT, METABOLIC RATES AND BODY AND SURFACE TEMPERATURES OF STARLINGS UNDER VARIOUS CONDITIONS AT 24–30 C AND 2–4 C

Temperature	24–30 C		2–4 C			
Condition	Roosting	Active	Roosting	Active	Roosting	Active
Grouping	single	single	single	paired	four	single
Tests	12	12	15	12	6	10
Birds	12	12	15	24	24	10
Average weight	69.375±	67.692±	67.986±	69.525±	72.852±	73.476±
	0.942	0.792	3.411	0.653	0.861	2.737
cc O_2/g–hr	2.86±	4.92±	5.83±	3.06±	3.04±	5.82±
	0.156	0.774	1.20	0.63	1.37	0.709
Kcal/24 hr	17.7±	28.7±	33.1±	17.5±	19.8±	34.8±
	3.7	3.5	4.7	2.4	0.80	3.98
Body temp. (C)	42.4±	42.6±	39.8±	38.8±	41.7±	39.3±
	0.12	0.16	0.28	0.43	1.02	0.45
Surface temp. (C)	38.4±	36.4±	31.7±	32.6±	35.3±	33.3±
	0.22	0.25	0.80	0.75	0.59	0.64

3.7 degrees and the mean decrease in surface temperature was 4.6 degrees. In the chamber for measuring active metabolism at 2–4 C the mean decrease in body temperature for 10 birds was 4.1 degrees. This decrease in body temperature is a further indication that the birds were in a roosting state in the chamber. The birds which were in groups of four at 2–4 C decreased their body temperature only 0.7 degree and their surface temperature decreased 2.1 degrees. The mean body temperature for 12 birds after 6 hours in a roosting state at 24–30 C was 42.4 C and the mean surface temperature was 38.4 C. Birds in an active condition at 24–30 C had a body temperature of 42.6 C and a mean surface temperature of 36.4 C.

Since their body temperature decreased 2.7 and 3.7 degrees respectively the birds roosting singly and in pairs at 2–4 C were in a state of hypothermia which is defined by Edholm (1961) as a condition in which the body temperature of an organism is lowered substantially below normal, perhaps a minimum of 2–3 C below the lowest temperature generally encountered in the particular species.

The birds that were in a state of hypothermia when placed in a cage with other birds at room temperature ruffled their feathers. The other birds in the cage flocked around the introduced bird. This ruffling of the feathers by a bird in hypothermia could be considered a similar response to piloerection in a cold mammal.

Four birds all of which had been roosting singly for 6 hours at 2–4 C

TABLE 2

COMPARISON OF OBSERVED AND CALCULATED SURVIVAL TIME UNDER VARIOUS METABOLIC CONDITIONS

Metabolic condition	No.	Mean initial body weight	Mean weight at death	% of initial weight at death	Observed survival time (days)	Calculated survival time	Chi-square
Roosting 24–30 C	4	69.8±	53.3±	76.4±	1.25±	2.78±	2.84
		1.61	0.89	1.49	0.19	0.30	
Roosting single 2–4 C	4	77.0±	63.0±	81.8±	1.00±	1.63±	1.54
		2.48	4.29	0.78	0.40	0.79	
Roosting paired 2–4 C	4	83.0±	65.8±	79.3±	3.08±	3.31±	0.86
		2.06	1.03	2.34	0.39	0.17	
Roosting 4 birds 2–4 C	4	72.0±	57.3±	79.6±	3.04±	2.78±	0.13
		0.78	1.95	0.98	0.31	0.95	

died within an hour after being removed from the respiration chamber. The mean body temperature was 30.5 C, a decrease of 12.1 degrees from normal (range 35 C–23 C). The mean surface temperature was 21.7, a decrease of 14.7 degrees. The duration of the hypothermic condition may have been the cause of death or the birds may not have been able to recover from such a severe drop in body temperature.

The mean respiratory quotient (RQ) decreased from 0.766 for birds roosting at 24–30 C temperature to a mean of 0.708 for all the different metabolic conditions at 2–4 C. A similar condition of a decrease in RQ occurred when chicks were exposed to cold was reported by Kleiber and Dougherty (1934).

The reserve energy supply and survival time under starvation conditions can be calculated from the formula described by Brenner and Malin (1965). The survival time under any given condition can be calculated from the formula $S = F/M$, when S = survival time (days), F = available energy in kcal, and M = the metabolic rate in kcal/day. All metabolic rates were calculated from the caloric equivalent of 3.408 kcal of energy per gram of CO_2 produced (Brody, 1945:310).

For the four birds which were fasted until death the calculated survival time did not differ significantly from the observed survival time when tested with a chi-square test (Table 2). The survival time increased as the number of birds increased in the chamber at 2–4 C (Table 2). The mean survival time increased from one day for a bird roosting singly to 3 days for birds roosting in groups.

The metabolic rate and reserve energy supply can also be calculated from the formula $S = F/M$. The calculated metabolic rates and the reserve energy

TABLE 3

COMPARISON BETWEEN OBSERVED AND CALCULATED METABOLIC RATES AND BODY FAT

Metabolic condition	No.	Observed metabolic rate (kcal/day)	Calculated metabolic rate (kcal/day)	Chi-square	Observed body fat (grams) (0.7W)	Calculated body fat (grams) ($S = F/M$)	Chi-square
Roosting singly, room temperature	4	17.7	24.1	1.70	5.55	2.82	1.34
Roosting singly 2–4 C	4	33.1	32.4	1.52	6.15	3.92	0.57
Roosting paired 2–4 C	4	17.5	22.6	1.15	6.59	4.95	0.33
Roosting group of four 2–4 C	4	19.8	20.5	0.66	5.71	5.70	0.18
Mean					6.00	4.35	0.45

supply of the birds in the different conditions were not significantly different from the observed values (Table 3).

DISCUSSION

The energy available to birds depends on the body weight. The basal metabolic rate also is dependent on the body weight and increases with a 0.73 power of the body weight (Brody, 1945). The relationship of weight to basal metabolic rate and available energy is also the formula for metabolic body size $W^{3/4}$ as described by Kleiber (1932). The energy available to an 80 gram Starling, if 0.7 is used for determination, is 56.0 kcal; if 0.75 is used, the available energy is 60.0 kcal. The small difference of only 4 kcal probably is not a significant influence on the survival time. The survival time may be further influenced by the activity of the bird.

There was an increase in survival time from one day for birds roosting singly to 3 days for birds grouped in fours at 2–4 C. This increase may result from a lower metabolic rate and heat loss per bird when the birds were grouped. In nature, the Starling will roost in conifer plantations, over water, or in the warmer area of cities where lights are on at night. The higher ambient temperature in these areas probably also aids in reducing the metabolic rate. The selection of the roosting area and the flocking behavior together both probably aid in survival during cold weather. Koskimies (1961) reported the swift (*Apus apus*) roosting in groups during the night in late autumn. Kleiber and Winchester (1933) showed that at 14 C, 3-week-

TABLE 4
METABOLIC RATES REPORTED FOR DIFFERENT SPECIES

Species	Metabolic rate cc O_2/g–hr or kcal/day	Investigator
Brown Towhee	2.8 cc O_2/g–hr	Dawson (1954)
Abert's Towhee	2.80 cc O_2/g–hr	Dawson (1954)
Evening Grosbeak	2.5 cc O_2/g–hr	Dawson and Tordoff (1959)
Cardinal	2.6 cc O_2/g–hr	Dawson (1958)
Red Crossbill	3.1 cc O_2/g–hr	Dawson and Tordoff (1964)
White-winged Crossbill	2.8 cc O_2/g–hr	Dawson and Tordoff (1964)
Red-winged Blackbird	2.90 cc O_2/g–hr	Brenner and Malin (1965)
Gray Jay	20 kcal/day	Scholander et al. (1950)
Snow Bunting	15 kcal/day	Scholander et al. (1950)
House Sparrow	11.7 kcal/day	Kendeigh (1944)

old baby chicks produced 15 per cent less heat per hour when they were allowed to huddle together than when they were separated. Small mammals also reduce their metabolic heat loss at low ambient temperatures by huddling together (Pearson, 1947; 1960; and Prychodko, 1958). A similar behavior occurs in poikilotherms. Brattstrom (1962) stated that tadpoles in aggregations absorb more radiant heat and dispense less heat to the surrounding water than do isolated tadpoles. The survival value of temperature-controlled aggregations in tadpoles appears to be related to an increase in body temperature.

Birds removed from the 2–4 C environment and placed in a cage at 24–30 C with other birds, ruffled their feathers. The other birds generally flew off the perch and gathered around the newly introduced bird. The other birds flying off the perch and gathering around the cold bird may be a reaction to a bird acting strangely in the cage. The result of the ruffle of feathers may be a reduction of heat loss, stimulation to flocking. or both. Baerends (1959) reported that birds brooding artificially cooled eggs would shiver, pant, and increase or decrease the body surface by erection or sleeking of feathers.

The metabolic rates obtained in this study compare closely with other studies (Table 4). This study also indicates that the thermoneutral range defined as the temperature range at which occurs the lowest metabolic rate for the species of birds may be altered by grouping birds at colder tempera-

tures. The Starling did not enter a torpid state as described for other species, and it is not known if a temperature lower than 2–4 C or a longer exposure to 2–4 C would produce torpidity in the Starling.

These data indicate that the Starling does not possess a physiological adaptation for cold, therefore the species may have evolved a behavioral adaptation of flocking to reduce heat loss and maintain its metabolic rate at the roosting level. Starlings roosting in conifers in the residential area of State College, Pennsylvania, were observed to be huddled together and body contact occurred between individuals. The size of this roost was estimated at over 5,000 individuals roosting in approximately 800 square feet. Emlen (1952) defined a flock as an aggregation of homogenous individuals, regardless of size or density. The flocking may arise as the result of a mutual attraction between individuals. The mutual attraction of flocking during the winter months could be a means of reducing the heat dissipation and metabolic rate. The flocking behavior of birds is probably essential to the survival of the species during cold weather if the species does not have a physiological or other behavioral adaptation to cold.

SUMMARY

The metabolic rates for roosting and active Starlings were determined at an ambient temperature of 24–30 C, and the metabolic rates of birds roosting singly, in pairs, and in groups of four were determined at 2–4 C. The metabolic rate of a bird roosting at 24–30 C was 2.86 ± 0.156 cc O_2/g–hr and was significantly lower than the metabolic rate for an active bird. The metabolic rate of a bird roosting singly at 2–4 C of 5.83 ± 1.20 cc O_2/g–hr was significantly higher than the rate of a roosting bird at 24–30 C and from the metabolic rate of 3.06 ± 0.63 cc O_2/g–hr for birds roosting in pairs and 3.04 ± 1.39 cc O_2/g–hr for groups of four birds roosting at 2–4 C.

The single and paired birds held for 6 hours at 2–4 C decreased their body temperature 2.7 and 3.7 degrees and the surface temperature decreased 5.7 and 4.6 degrees, respectively.

The expected survival time was calculated from the body weight and metabolic rate under various conditions. The observed and expected survival time were not statistically different on the basis of a chi-square test. The survival time increased from one day for a bird roosting singly to 3 days for grouped birds at 2–4 C.

The Starling did not enter a torpid state as described for other species and therefore may have evolved a behavioral adaptation of flocking to reduce heat loss and maintain its metabolic rate at the roosting level. The flocking behavior may be essential to the survival of the species during inclement winter weather.

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ADAPTIVE BEHAVIOR UNDER HANDICAPS OF SEVERAL SPECIES OF MICHIGAN BIRDS

Walter P. Nickell

During the last 33 years (1932–64), in the course of banding more than 120,000 birds, I have recorded numerous examples of foot, beak, and wing defects which might be expected to seriously handicap several species of birds in feeding, perching, and moving around in their normal environment. I have noted that many of these birds were able to adapt themselves to these handicaps, provided they were not too severe, in ways that enabled them to continue for some time to feed and move around the landscape. By far the greater number of these defects were of a minor nature, such as the loss of a whole front or hind toe, or only the forward joint on some of these appendages, or the lack of a small amount of both upper and lower mandibles and/or the loss of the tips of either. Occasionally a more severe defect was observed, as in the example of Mourning Doves losing part or all of their toes on one or both feet (Nickell. 1964. The effects of probable frostbite on the feet of Mourning Doves wintering in Southern Michigan. *Wilson Bull.*, 76:94–95).

Downy Woodpecker (*Dendrocopus pubescens*)—On 9 September 1961 I captured by net a female Downy Woodpecker at Cranbrook, Bloomfield Hills, Michigan. I immediately observed that this bird did not have a right leg nor was there any evidence that it had ever developed one in the embryonic stage. There was no scar nor any sign of a break in the skin. When I pulled the feathers aside and gathered the skin between my forefinger and thumb, I felt a small lump of what appeared to be cartilage at the place where the leg would normally be attached to the body. This bird was banded on the left leg and released. It immediately flew to about 10 feet above the ground on the trunk of a nearby tree and began its ascent, but in an abnormal fashion. Instead of climbing vertically, it climbed rather awkwardly at a diagonal. I observed this bird through 7×35 field glasses at a distance of about 30 feet for several minutes. Its right wing was open and the shoulder was pressed against the bark. evidently in compensation for the absence of its leg (Fig. 1). It was handicapped in its efforts to climb and move around the trunk of the tree. However, this bird had undoubtedly survived in this condition for some time as it was apparently healthy. The under portion of the shoulder of the wing was calloused and rough, indicating that it had used the wing in the fashion described above since leaving the nest.

Purple Martin (*Progne subis*)—In early June 1940 an adult male Purple Martin was brought to me with a badly injured right wing. I attempted to place splints on this wing as no bones were protruding, but the bird would

FIG. 1. Female Downy Woodpecker with wing extended, showing compensation for absence of right leg. Drawn by Betty Odle.

not accept the splints and bandage, tearing them off with its beak within a short time. I placed another splint and bandage on the wing with a neck-yoke attached in an attempt to prevent the bird's getting at the injured wing with its beak and feet. Almost immediately it grasped the neck-yoke with its feet. nearly strangling itself. I immediately removed the bandage and yoke, deciding to let nature take its course.

Realizing that this bird in nature obtains most of its food and water on the wing. I wondered if it could be taught to eat without force-feeding. I placed a shallow clear glass laboratory dish of mealworms (*Tenebrio obscurus*) before it and another dish with water. The squirming of the mealworms elicited some interest, but it made no effort to pick them up. It apparently did not recognize the water. This behavior lasted for about 4 days during which time I force-fed the bird. I also forced its beak down into the water, but it would make no attempt to drink. I therefore dropped water into its throat from a teaspoon. It swallowed the water also. After repeating the feeding–watering procedure for about 30 times during the 4 days, I decided to place the food and water before it (5th day) and leave it to its own devices for at least a half day. At first the bird stood for several minutes, showing considerable interest in the wriggling of the larvae, then without further hesitation waddled up to the food dish and began to gulp down the mealworms. When it had eaten an estimated 25 mealworms it moved to the water dish, dipped its beak in. and, after the fashion of the Robin or other small birds, drained the water down the throat by raising its head. For the next 3 months all I needed to do was to place the food and water before it in a regular place. This bird was not caged, but had the free run of the floor of a 30- × 20-foot room. A chair with rungs about 6 inches above the floor served as its roosting place. It became quite tame so that each morning when I came into the room it jumped down from its perch on the chair rung and waddled quickly over to the food and water containers, beginning to eat and drink immediately.

At the end of the 3 months' period I had to leave my laboratory for about 2 weeks after giving explicit instructions to our building janitor for the bird's care. When I returned I found that the bird had died, almost certainly from starvation. The wing had healed, but was useless for flying. I have often wondered whether this bird would have reassumed its normal feeding and watering habits if its wing had healed and if it had been released into the wilds again.

Blue Jay (*Cyanocitta cristata*)—In July 1959 I captured an adult Blue Jay which had its lower mandible broken off to within about one-half inch of the skull. Though this was a jagged break it had apparently healed perfectly so that the bird had been able to gather food for some time.

Robin (*Turdus migratorius*)—In the early summer of 1946, also at Cran-

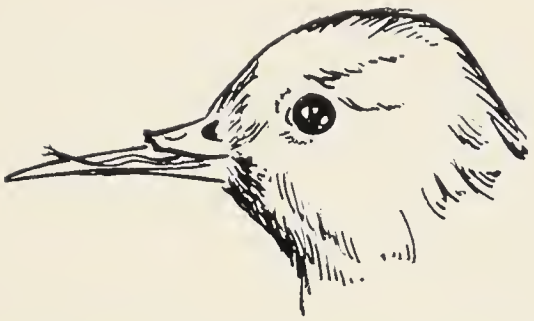

FIG. 2. Female Baltimore Oriole with part of upper mandible missing. Drawn from life by Betty Odle.

brook, I observed a male Robin which had lost its right leg. This bird moved apparently without great difficulty with a hopping gait as it probed for earthworms on my front lawn. I was unable to note whether it encountered any difficulty in perching as, when approached, it would fly over my house to land on the ground again. The next summer there was a male Robin with only one leg, which exhibited the same behavior at the same place.

Baltimore Oriole (*Icterus galbula*)—On 21 May 1964 at Cranbrook I captured a female Baltimore Oriole which had lost at least ⅔ of the upper mandible (Fig. 2). This had healed and was apparently causing the bird comparatively little difficulty, although I strongly suspected that it ran into more difficulty than was observable if it attempted to nest. That it may have been mated and perhaps nested close by was evidenced by my capturing an adult male in the same net at the same time. I was surprised to find that the tongue lying in the trough of the lower mandible was not dry, but appeared to be well moistened by saliva flowing from the mouth. This bird was not captured again, although the male which had accompanied it at the time of banding did repeat on 30 May. There is a possibility that the female may have struck the net two or three times after banding without becoming entangled, as on three occasions strands of bark fibers of swamp milkweed (*Asclepias incarnata*), which is the major nest structural material of the Baltimore Oriole, were found hanging in the net. As this bird had almost undoubtedly met its accident in the tropics or on its way north in migration, I am led to believe that it had overcome its handicap sufficiently to cover some distance and to feed itself in transit.

Common Grackle (*Quiscalus quiscula*)—On another occasion I noted an adult male Common Grackle which had lost more than ⅔ of the lower mandible. This also had healed and the bird showed no noticeable emaciation as a result of its accident. F. H. Allen (*in* Bent. 1958. *U. S. Natl. Mus. Bull.*, 211:412) observed during two summers a male grackle whose upper mandible was about twice as long as its lower. It was also decurved, flattened,

and had a squarish tip. When feeding on the ground this bird had to turn its head sidewise in order to pick up its food. This is the only reference I have found in the literature relating to this kind of defect in the grackle and its resultant adaptation.

White-throated Sparrow (*Zonotrichia albicollis*)—On 15 May 1950 I captured a brightly marked White-throated Sparrow at Cranbrook. When holding the bird for banding I noted that it had only one leg, the right. When the feathers were parted on the left side, I found no sign of a stump. As in the case of the Downy Woodpecker, mentioned above, I felt a small lump of apparently cartilaginous material underneath the skin. Again, this was evidently an embryonic defect. When I released the bird in an open field I observed no irregularities in its flight. When it perched on the branch of a large elm, it apparently made a perfect landing and showed no sign of imbalance.

Slate-colored Junco (*Junco hyemalis*)—On several occasions I have captured Slate-colored Juncos with portions of upper and/or lower mandibles missing with the wounds healed as in the examples mentioned above.

CRANBROOK INSTITUTE OF SCIENCE, BLOOMFIELD HILLS, MICHIGAN, 12 FEBRUARY 1965

CORRECTION

Charles E. O'Brien has kindly called our attention to a regrettable error in our description of *Icterus prosthemelas praecox*, where the type is stated (*Wilson Bull.*, 77:298) to be No. 392316, American Museum of Natural History (R. R. Benson original field no. 797). The latter number is correct, but the museum number is actually 248065. We apologize for this inexcusable lapsus and thank Mr. O'Brien for his courtesy in pointing it out.—Allan R. Phillips, *Instituto de Biología, Universidad Nacional Autónoma de México, México, D. F.*, and Robert W. Dickerman, *Department of Microbiology, Cornell University Medical College, New York, New York, 1 December 1965.*

GENERAL NOTES

Sight record of the Scarlet Ibis for Alabama.—On 9 May 1964, an adult Scarlet Ibis (*Eudocimus ruber*) was observed in a White Ibis (*Eudocimus albus*) nesting colony located about 15 miles southeast of Dothan, Houston County, Alabama. The ibis was perched in the top of a tupelo (*Nyssa biflora*) tree preening its feathers. No fear was displayed by the bird as it was observed from a distance of 150 feet through 7×50 binoculars and was color photographed through 8×40 binoculars in the late afternoon. The bird was observed for about 15 minutes, before it flew away. There was no evidence of bands or other markings to indicate the origin of the bird. Although the bird was not collected, the observation was verified by Dr. Julian L. Dusi, Professor of Zoology at Auburn University, who was conducting a study of herons in the area at that time. No additional sightings have been made to June 1965.

"A Manual of the Ornithology, the Water Birds, of the United States and of Canada," written by Thomas Nuttall (1834. p. 84) is the only reference used by the authors of the Alabama ornithology books. Howell (1928. "Birds of Alabama" p. 71) and Imhof (1962. "Alabama Birds" p. 109) refer to Nuttall's statement, "This brilliant and exclusively American species, inhabits chiefly within tropics, abounding in the West India and Bahama Islands, and south of the equator, at most, as far as Brazil. They migrate in the course of the summer (about July and August), into Florida, Alabama, Georgia, and South Carolina; but retire into Mexico, or the Caribbean Islands, at the approach of cool weather." Imhof (op. cit.) commented, "It is doubtful that new definite sight records will be obtained because the immature birds, which are the great wanderers, are virtually impossible to distinguish from immature White Ibises."

Palmer (1962. "Handbook of North American Birds." Vol. 1:530–531) listed for North American distribution nine possible records from Texas (some occurred after tropical storms), Audubon's questionable sight record from Louisiana, and the A.O.U. Checklist records from Honduras, Costa Rica, and Jamaica. He lists, also, an ibis found dead in Dade County, Florida, 12 November 1954, that was possibly an escapee.

Robertson (1962. *Audubon Field Notes*, 16:470) indicated in his nesting season reports for the Florida Region that a number of Scarlet Ibises had been reported in the Tampa Bay area. Six Scarlet Ibises were known to have escaped from the Busch Gardens; another one was reported seen for two consecutive days at the Myakka River State Park. He also mentioned the experiment of Carter Bundy.

Carter Bundy (1962. *Florida Naturalist*, 35:87) reported an experiment in July 1961, in which 22 eggs were obtained from Trinidad, and placed under brooding White Ibises in the Greynolds Park rookery, north of Miami, Dade County, Florida. Seventeen of the fledglings survived of which the oldest birds were 11 months, at the time of his article.

The Scarlet Ibis sighted and reported here could have been an escapee from the Tampa Gardens or the Greynolds Park colony. It also could have been a wanderer from the natural area of distribution. Regardless of its origin, it arrived in Alabama, and its sighting is given for the record.—Rosemary T. Dusi, *560 Sherwood Drive, Auburn, Alabama, 26 June 1965. (Originally submitted 8 September 1964.)*

Osprey preys on turtle.—On 27 September 1964 at about 5:00 PM, the following observation was made at Big Creek, southeast of Amherstburg (Concession II, one mile north of Highway 18 in Malden Township), Essex County, Ontario.

We saw an Osprey (*Pandion haliaetus*) hunting along Big Creek. The bird dove out of sight and was seen to arise with a dark object held by one foot. The bird circled about, apparently looking for a perch on which to devour its prey. It landed on a telephone pole about 50 feet from us, at which time we could see that the object dangling from the bird's foot was a turtle. The turtle, which was thought to be a painted turtle (*Chrysemys picta*), appeared to be about 4 to 6 inches long. Unfortunately the Osprey flew up again and circled around until it was out of sight. We did not see whether it ate the turtle.

Bent (1937. "Life Histories of North American Birds of Prey," Part 1, *U.S. Natl. Mus. Bull.* 170, p. 369) quotes B. R. Warriner (1934), who describes an Osprey taking a turtle, which it could not hold, however. The Osprey we saw had no trouble holding on to its turtle. The above is the only reference we could find to an Osprey preying on turtles.—Sergej Postupalsky, *2926 West Thirteen Mile Road, Royal Oak, Michigan,* and Joseph P. Kleiman, *3271 Albert, Royal Oak, Michigan, 27 November 1964.*

Ring-billed Gulls gorge on fiddler crabs.—While assisting in the St. Petersburg, Florida, Christmas census on 29 December 1962, I made the following observations on the feeding behavior of Ring-billed Gulls (*Larus delawarensis*) foraging at the western end of the Howard Frankland bridge in Tampa Bay.

At 1230 hours I was standing at the edge of a strip of red mangroves (*Rhizophora mangle*) bordering 4th Street watching the maintenance activities of 25 Ring-billed Gulls resting on a mud flat near the mangroves, a loafing area that was regularly used by the gulls. Some of the gulls were preening, others were resting with bills on their backs, some were simply looking about. A narrow tidal creek entered the open water near the mud flat where the gulls were located. Several of the gulls closest to the tidal creek flew up at 1232 hours, patrolled the creek for a minute or so, hovered for a few moments, called loudly, then settled hurriedly on the narrow flats bordering the creek. Almost at once the remaining gulls joined the small group along the creek. I moved closer to see what had attracted the gulls and saw that the flats along the creek were literally teeming with fiddler crabs (*Uca pugilator*).

The 25 gulls began to gorge themselves with crabs; this group was soon joined by an additional 50 Ring-billed Gulls. The entire group continued to feed in a frenzied manner for about 2–3 minutes, and then the entire flock rose almost in unison, flew over 4th Street, settled at the edge of a different tidal creek, and began to mill about and call loudly. I ran across 4th Street and saw that the gulls had settled near a horde of fiddler crabs that were milling over the mud flats at the edge of the red mangroves. Within 5 minutes an additional 100 gulls had joined the first group. The gulls gorged on the crabs, flew up in small groups, settled again, called loudly, flew over the mangroves, settled at another tidal creek, and then repeated this behavior many times. By 1300 hours I estimated that 1,500 Ring-billed Gulls had been attracted to the abundant food source, probably by a combination of visual and auditory stimulation from the milling flocks already present.

I watched the manner of prey capture and food handling repeatedly: a gull would land among the milling crabs, briefly chase one and then seize it, and then the gull would appear to deftly remove the enlarged cheliped with a snap of its mandibles, although autotomy was more likely the cause of cheliped loss. Usually the crab dropped from the gull's grasp along with its severed cheliped, but the gull simply ran after the crab, grasped it, and then tossed it down its gullet hurriedly. One gull I watched

captured, handled, and swallowed 15 crabs in rapid succession. I saw another gull whose throat bulged from engorged crabs, and when I chased it the bird barely evaded my grasp.

Most of the crabs simply milled about in the confusion, but many of them scurried into the short red mangroves; it was noteworthy that the gulls did not pursue any of the crabs into the mangroves. As soon as a flat had been almost cleaned of crabs the gulls would rise, mill about, fly over the denser mangrove area, locate another throng of crabs in the open, then descend and feed as rapidly as possible. By 1315 hours almost all of the gulls had left the mangrove area and flown out over Tampa Bay or had returned to the nearby loafing area. Many crabs remained along the margins of the tidal creeks, but apparently the gulls had been satiated by the superabundant food supply. I saw no signs of any unusual disturbance, and I doubt that my presence drove the gulls away. I walked up and down the edges of the creeks for about 10 minutes and saw that the flats were strewn with severed chelipeds; I found a few badly damaged whole crabs but mostly severed claws. At this time most of the crabs were either in tangles of short red mangroves or else hiding in burrows. Perhaps the general movement of the crabs into such cover stalled the frenzied foraging of the gulls, even though a few crabs were still vulnerable as they scurried over the open flats.

Several Herring Gulls (*Larus argentatus*) and hundreds of Laughing Gulls (*Larus atricilla*) were definitely within visual and auditory range of the screaming, milling Ring-billed Gulls, yet I did not see a single individual of either species attracted to the bountiful food supply. Five raccoons (*Procyon lotor*) were seen foraging on a mud flat several hundred yards from the main feeding area of the Ring-billed Gulls, but I did not see any overt indication that the raccoons were aware of the gulls' activities.

Frings, Frings, Cox, and Peissner (1955. *Wilson Bull.*, 67:155–170) described and recorded a food-finding call of the Herring Gull, and they were able to demonstrate that playbacks in the field of this call succeeded in attracting gulls of this species to the sound source area from a distance of 3–5 km. Such calls are known from a few other species, particularly in parent–young food relationships (Collias, 1960. Animal Sounds and Communication. Amer. Inst. Biol. Sciences, Washington, D.C., pp. 369–370). I do not know if Ring-billed Gulls have a food-finding call; I was not able to record and experiment with their vocalizations. Thorpe (1961. Bird-Song. Cambridge Univ. Press, p. 24) suggests that food-finding calls "are probably rather unusual since it will only be desirable to attract a large number of individuals of a species to a particular food source from over a wide area when that food source is both abundant and ephemeral." The fiddler crabs were clearly abundant, and they were ephemeral in the sense that they were no longer available as food for the gulls once they took cover in burrows and in the dense, short red mangroves. If the Ring-billed Gull does have a food-finding call it might account for the very rapid gathering of gulls I saw, but visual attraction cannot be ruled out until experimentation reveals an acoustic attraction signal. I do not know why the Herring and Laughing Gulls were not attracted to the abundant food supply; they were within visual and auditory range, and later I saw several individuals of these two species foraging on a nearby mud flat, which suggests that they were not satiated from prior foraging activities while the Ring-billed Gulls were gorging on the crabs. Seemingly the temporary superabundance of fiddler crabs would have permitted feeding without competition by the three species, but only the Ring-billed Gulls were opportunistic at the time of my observations.—Andrew J. Meyerriecks, *Department of Zoology, University of South Florida, Tampa, 30 October 1964.*

Intraspecific relationship in Red-shafted Flickers.—On the afternoon of 14 November 1964, a Red-shafted Flicker (*Colaptes cafer*) was observed apparently attempting to rescue another Red-shafted Flicker that had been caught in a mist net.

I was attracted to the scene in the backyard of my home in Oak Creek Canyon, Zion National Park, Utah, by the loud and insistent calls of both birds. Upon observing the birds through 9 × binoculars at a distance of about 55 feet, I found that a female flicker had been caught in the lowest strand of the net and was hanging only a few inches above the ground. The male flicker, standing on the ground directly beneath the female, was able to reach the female's bill with its own. They clasped each other's bill and both birds appeared to tug. After seven or eight tugs, the male jumped onto the body of the female and began pecking at the net strands, all the time calling in a loud manner typical of an annoyed flicker. He then jumped back onto the ground and again clasped the female's bill with his and began backing away, with the help of wing beats, apparently trying to pull the female free of the net. He suddenly released his hold and flew at the net. He again jumped upon her body and began a vigorous pecking at the net strands. Just as suddenly he jumped back onto the ground and began the tugging process again.

I watched these actions for about 6 minutes. Then, noticing that there was blood from an apparent cut on the female's loreal region, I approached the net to release the bird. The male then flew only a short distance away to a scrub oak where he began a "*chuurr-ing*" call and bobbed up and down in a manner I have seen woodpeckers do when they are excited. I banded and released the female, who flew to a rock about 40 feet up the slope from the male. She began a constant calling which was immediately answered by the male, and within 30 seconds he flew to her and they disappeared up canyon together.—Roland H. Wauer, *Zion National Park, Utah, 21 January 1965.*

A melanistic Pileated Woodpecker specimen from Georgia.—While arranging specimens of Pileated Woodpecker (*Dryocopus pileatus*) in the U.S. National Museum, I found an almost entirely black female that immediately reminded me of the Old World Black Woodpecker (*D. martius*). This specimen (USNM No. 268901) was collected 2 November 1917 in the Okefinokee Swamp of Georgia by Harrison Lee, and is in good condition except for some feathers missing from portions of its head and neck. The bird was completing its annual molt (the central rectrices and eighth primaries were coming in and the other rectrices and inner seven primaries were new). It is an adult individual as indicated by its relatively short and narrow tenth primaries (until their first prebasic molt is nearly completed, woodpecker young of the year are usually distinguishable from adults by their longer and broader tenth primaries).

The specimen's underparts lack any indication of the white feather edges often noted in Pileated Woodpeckers. The white wing patches, characteristic of that species, are entirely lacking, and white is visible only on the underside of the wings, as a fine mottling on a few covert feathers and the inner bases of primaries 5–7. The shafts of the remiges (but not the rectrices) exhibit some dusky white near their bases, and not the sharply setoff black and white stripes normally found in *D. pileatus*. The head and neck lack the striking white marks so characteristic of the Pileated Woodpecker. The only white visible on the head and neck is that normally found beneath the red of the crest feathers, and a few vague traces on the edges of some malar feathers.

The remainder of its plumage, including the mottled brown and black forehead, is like that of a normal female Pileated Woodpecker. There is one other apparent abnormality—its extremely long and narrow bill. Its bill length (culmen = 54.2 mm)

is greater than measurements listed for females of all races of *D. pileatus* by Ridgway (1914. Birds of North and Middle America. Part VI. *U.S. Natl. Mus. Bull.* No. 50). Compared with females in the U.S. National Museum, this specimen's bill is longer than: that of every southeastern specimen (*D. p. pileatus, D. p. floridanus*), those of most northeastern (*abieticola*) females, and those of some northwestern (*picinus*) specimens Not only is the bill extraordinarily long in this melanistic bird, but it is also narrower (12.2 mm wide at center of nostrils) and less massive than those of all the adult female specimens of *D. pileatus* that I examined.

This unusual specimen approaches *D. martius* in the virtual absence of white in its plumage, although it does not tend toward that species in other features, such as *martius'* larger size and restricted crest. Nevertheless, there is a striking resemblance between this abnormal specimen of *D. pileatus* and *D. martius*. The plumage pattern of the Pileated Woodpecker is intermediate between the generally barred and more patterned, tropical, New World species of *Dryocopus*, and the less patterned and larger Old World species, *D. martius* and *D. javensis*. The melanistic Pileated Woodpecker described above suggests that genetically simple, melanic tendencies may have played a role in evolution of *pileatus, martius*, and *javensis* from ancestral (tropical American?) forms.—Lester L. Short, Jr., *Bird and Mammal Laboratories, Fish and Wildlife Service, U.S. National Museum, Washington, D.C., 11 February 1965.*

Duet Singing in the Carolina Wren.—Based on observations I have made in South Carolina and Florida I have concluded that the male and female of mated pairs of Carolina Wrens (*Thryothorus ludovicianus*) regularly sing duets.

The duet consists of the male's three- or four-note phrases repeated four or five times. The female joins in, usually toward the last notes of the first phrase with a buzzy, rather high-pitched trill which lasts well into the second phrase of the male's song. The trill of the female has not been heard by me except when the male was singing, though a somewhat similar lower pitched trill is sometimes used by Carolina Wrens. The female does not always join the song of the male, but in the pairs that I have observed she usually sings once or twice in a series of songs by the male, most often toward the start of a singing session. I have seen a female join in with a male in singing when a third bird appeared in the vicinity. In this case she came from a short distance away and hopped to a position just below and about a yard away from the male.

A recent observation, 19 November 1964, at Greenville, South Carolina, involved two pairs of Carolina Wrens. A male in my yard started to sing and was joined by his mate. Across the street a second male answered along with its mate.

I have heard Carolina Wrens singing duets in McClellanville, South Carolina and Sebring, Florida, as well as in Greenville, South Carolina. I have heard duets sung in all seasons of the year.—James B. Shuler, *43 Kirkwood Lane, Greenville, South Carolina, 30 November 1964.*

Bluebirds feeding Mockingbird nestlings.—On 14 May 1964, we observed a pair of Eastern Bluebirds (*Sialia sialis*) feeding Mockingbird (*Mimus polyglottos*) nestlings. Feeding of nestlings of one species by adults of another species has been reported for other species pairs but seems not to have been recorded for bluebirds and Mockingbirds.

The observation was made at Dr. Archie Carr's residence in Micanopy, Alachua County, Florida. The Mockingbird nest was on a low-hanging limb of a slash pine, approximately 4 feet above ground. Eighteen feet up the trunk of the same tree was a bird box; in a

FIG. 1. *Bluebird feeding Mockingbird nestling.*

similar one at the same height in a tree 30 feet away, bluebirds had nested successfully in 1963. It is not known whether the bluebirds had yet nested in 1964. There were five Mockingbird nestlings, date of hatching unrecorded. Both the bluebirds and the Mockingbirds would feed and/or remove the fecal sacs every few minutes. When the Mockingbirds spotted the bluebirds at the nest, they would chase them off. The photograph shows one of the bluebirds feeding the nestlings.

On 24 May, the nest was observed continuously for one hour. During this time, the Mockingbirds fed the nestlings 12 times and the bluebirds fed them 11 times. This occurred in an alternating pattern. Also, during this time the Mockingbirds chased the bluebirds away seven times.

This pattern continued even after the Mockingbird young learned to fly, but as they ranged farther from the nest, it became harder to keep track of them. The last positive sight of feeding by bluebirds was at 6:00 PM, 7 June. A few days later the bluebirds built a nest which was unsuccessful for unknown reasons.

We wish to thank Dr. and Mrs. Archie Carr for helping with the observations and Dr. and Mrs. Coleman J. Goin for helping in the preparation of the manuscript.—Thomas Carr and Coleman J. Goin, Jr., *Gainesville, Florida, 19 January 1965.*

Some records of North American migrants in Ecuador.—With a view toward determining the relative abundance of North American migrants in the tropics in spring, I spent late April and much of May 1964, in Ecuador. During my few days around Quito (18–20 April) it proved possible to obtain fairly accurate counts of birds, even though a few were not satisfactorily identified because of my inexperience with them. In this small sample were found a total of four North American migrants out of 321 birds counted (1.2% of the total). On 21 April my headquarters were transferred to Limon Cocha, a mission station located near the junction of the Rio Napo and Rio Jivino at an elevation of 900 feet. Here the great abundance of birds strange to me, along with the profuse cover, made even rough estimates inadvisable, although the relatively few North American birds presented no problem. In the belief that their departure dates from Ecuador are only imperfectly known, my observations are presented here.

Solitary Sandpiper (*Tringa solitaria*).—One at a small pond in a cattle pasture, Limon Cocha, 29 and 30 April and 2 May.

Lesser Yellowlegs (*Totanus flavipes*).—One at Limon Cocha, 5 May.

Pectoral Sandpiper (*Erolia melanotos*).—Two at Limon Cocha on 5 May and one the next day were a source of surprise, as these would be considered late dates even in Florida.

Eastern Kingbird (*Tyrannus tyrannus*).—Decidedly the most common of North American migrants. Three at Quito, 18 April. From 22 through 25 April the daily numbers at Limon Cocha ranged from about 5 to 20. Smaller numbers remained until the last bird was seen on 9 May.

Traill's Flycatcher (*Empidonax traillii*).—One seen and collected at Limon Cocha, 29 April (FSU No. 4662a).

Bank Swallow (*Riparia riparia*).—Single birds seen in the cattle pasture at Limon Cocha, 2 and 9 May.

Barn Swallow (*Hirundo rustica*).—A few were encountered at Limon Cocha on 21 and 30 April.

Blackpoll Warbler (*Dendroica striata*).—One female at Limon Cocha, 24 April.

Bobolink (*Dolichonyx oryzivorus*).—A few at Limon Cocha, 26 and 28 April and 1 and 2 May. Total recorded, 9.

Savannah Sparrow (*Passerpculus sandwichensis*).—At 10,000 feet in the denuded mountains east of Quito on 19 April I recognized the weak call note of a Savannah Sparrow. Easily located at short range, it was studied with 10 × 50 field glasses and determined to belong to one of the darker races. Only later did I learn that the species was previously unrecorded from Ecuador (Chapman, 1926. *Bull. Amer. Mus. Nat. Hist.*, 15.) or Colombia (de Schauensee, 1964. "The birds of Colombia"), thus my collecting efforts were directed toward indigenous species. It is hoped that calling the occurrence to the attention of others may lead to eventual substantiation of this sight record.

The work described above was supported in part by a grant from the Communicable Disease Center (U.S. Public Health Service). From the time of my arrival in Quito, Donald Johnson, director of the Instituto Linguistico de Verano, assisted me in more ways than I can mention.—Henry M. Stevenson, *Department of Biological Science, Florida State University, Tallahassee, Florida, 5 March 1965.*

Birds develop a taste for sugar—It is a common occurrence for Bananaquits (*Coereba flaveola*) in the West Indies to visit the sugar bowls of dining tables to secure one of their favorite foods. On some of the islands, "sugar bird" is the familiar name for this species. Many residents, hotels, and restaurants, cater to their appetites by placing bowls of sugar along porch rails. Some eating places, however, inquire of the guest "how many spoonsful," and serve the coffee, or the iced drink, according to direction rather than place the sugar within easy reach on the table. Thus they try to avoid annoyance to guests who might object to having the tiny and colorful birds eat from the sugar bowl, take a drink from the water glass, and bathe in the finger bowl. We have watched with much pleasure the birds doing all of these things at the Piscadera Bay Club in Curaçao.

It was a distinct surprise, on returning to Tobago this past April, to find species of birds other than the Bananaquit now relishing sugar. At the Arnos Vale in Plymouth, where we stayed with the Florida Audubon Tour Party, two species of tanagers, the Blue-gray (*Thraupis virens*) and the White-lined (*Tachyphonus rufus*), and one species of woodpecker, the Little Red-headed (*Centurus rubicapillus*) came steadily to the sugar dishes from early morning to dusk. This zest for sugar probably dates back to the period following the hurricane of September 1963, when much of the foliage was blown off the trees and shrubs. Food was scarce, and many people interested in birds found them thronging about their houses in search of food. Egbert Lau of the Bird of Paradise Inn, Speyside, wrote us soon after the hurricane that he had 50 or more Blue-gray Tanagers at one time feeding largely on bananas and other fruits which the tanagers regularly relish. Alexander Skutch (1954. "Life Histories of Central American Birds. *Pacific Coast Avifauna*, 31) speaks of their coming regularly to his feeding shelves, but the main food offered and taken seems to be bananas. Apparently, the habit of eating sugar was a direct result of the shortage of regular foods, and perhaps they imitated the Bananaquits which were already sugar addicts.

Will this habit remain fixed? It is possible that it will, for in April of 1964, more than 6 months after the hurricane there seemed to be plenty of natural foods to support these birds, but they continued to eat large quantities of sugar.

There were also a number of species in Tobago which came this year regularly for bread, either dry or soaked in water: Black-faced Grassquits (*Tiaris bicolor*) and other finches; Ruddy-breasted Seedeaters (*Sporophila minuta*); Blue-black Grassquit (*Volatina jacarina*); and Yellow-bellied Seedeater (*Sporophila nigricollis*); also, doves such as Eared (*Zenaida auriculata*) and White-fronted (*Leptotila verreauxi*). Surprisingly the Barred Antshrike (*Thamnophilos doliatus*) seemed to relish this food. Other species which partook of the bread, included: Glossy Cowbird (*Molothrus bonariensis*); Antillean Grackle (*Quiscalus lugubris*); Tropical Mockingbird (*Mimus gilvus*); and Bare-eyed Thrush (*Turdus nudigenis*). Blue-crowned Motmots (*Momotus momota*) had also learned to depend on human aid. One bird in particular would regularly take a cherry from the palm of a guest. Furthermore, these birds would appear at the breakfast table of guests, perch on the back of a chair, or the table itself, and take bits of papaya and watermelon. A guest awoke one morning to find a motmot sitting on the bedrail waiting patiently for a breakfast snack.—Margaret H. Hundley and C. Russell Mason, *Florida Audubon Society, Maitland, Florida, 1 February 1965.*

A CRITIQUE CONCERNING FOREIGN GAME BIRD INTRODUCTIONS[1]

Gordon W. Gullion

In 1956, after the federal foreign or exotic game bird program had been underway for about 7 years, Robert Pierce presented some timely thoughts concerning this program to *Wilson Bulletin* readers. At that time he suggested (p. 82) that "the desires and advice of biologists and conservation organizations other than those directly concerned with hunting might well be given consideration by both federal and state agencies." Although the indications may be slow in coming, not all game biologists "directly concerned with hunting" have been in favor of the exotic bird program, and it is my belief that the majority are opposed, feeling that it is a futile diversion of scarce financial and manpower resources. It seems the support of the program has been based on the demand of some segments of the hunting public for more game to shoot, and rather than face the reality that most of our problems can be resolved by more efficient utilization of extant game resources, some members of the wildlife profession have looked to foreign lands seeking species which will supposedly thrive where our native species will not. I believe it is safe to say that many biologically trained administrators officially supporting this program are doing so in conflict with their personal beliefs.

When critics of the exotic game bird program voice an objection to more introductions the proponents point to the success of the Ring-necked Pheasant (*Phasianus colchicus*), Hungarian or Gray Partridge (*Perdix perdix*) and Chukar or Rock Partridge (*Alectoris graeca*) as examples which were highly successful in their "new environment" in North America (Bump, 1951:325). Ignored or overlooked are the histories of dozens of species introduced in substantial numbers which have failed completely. Also forgotten are the many species of native birds shifted to new environments on this continent which have failed to "acclimatize," although there have been some notable successes, as with the Wild Turkey (*Meleagris gallopavo*).

Perhaps a more critical look should be taken at the factors favoring establishment of the three exotic game species which have done so well. First, were they introduced into "new environments"? They were certainly introduced to new geographical environments, but each was preceded by the type of habitat in which they thrived in the Old World. When the first European settlers arrived on North American shores pheasant and Gray Partridge habitat was first introduced to this continent. As the settlers moved westward, turning forests and prairie into fields growing the same grains and weeds grown in Europe for many centuries, pheasant and "Hun" habitat was extended across the continent, finally reaching the Willamette Valley, Oregon, well ahead of the first release of pheasants there in 1881. Neither the pheasant nor Gray Partridge had to adapt or change to thrive in the same ecological niche they had lived in for centuries before their introduction in North America (Westerskov, 1964). Probably neither could have prospered unless agriculture had paved the way.

The story of the Chukar Partridge is essentially the same. This bird is thriving only in the western arid regions similar to its native habitat in Asia, and generally only where it was preceded by its staple food plant, cheatgrass (*Bromus tectorum*). As

[1] Paper No. 5632, Scientific Journal Series, Minnesota Agricultural Experiment Station, University of Minnesota, St. Paul.

Christensen (1954:12) points out, many tens of thousands of chukars have been introduced into other parts of the nation. When these areas lacked dry, snow-free mountain slopes and cheatgrass, the chionophobic chukars did not become established. Bump (1963:857) recently stressed the fact that the establishment of the Chukar Partridge in Nevada was the result of the release of a very few birds. Which is true—a very few birds in situations which apparently *were identical to their native haunts.* Bump does not point out that chukars failed to become established when released in many other Nevada habitats which differed only slightly from the situations in which successful establishment occurred (Christensen, 1954:16–20). In New Mexico, certainly arid in many places, the release of over 7,600 chukars failed completely, although the birds were released under basically the same conditions of rearing and handling as those which succeeded in Nevada (Bohl, 1957).

Proponents of the introduction of exotic game birds use the term "adaptation" or "acclimatization" quite freely, yet none of the exotic game birds successful in this country at the present time have shown any success in "adapting" or "acclimatizing" to a new environment.

The pheasant and Gray Partridges are still basically birds of small grain farmlands, showing little success in cotton fields or on the western rangelands away from cultivated fields. The chukar occupies a very restricted ecological niche in the arid west, succeeding only in canyons or on mountain slopes where infrequent winter snow is quickly melted enabling them to find cheatgrass and other seeds before starvation takes its toll. Hence these species have shown no adaptability to environments different from those they have long been accustomed to (Formozov, 1946).

Lack of adaptation or acclimatization to new environments is certainly readily apparent in our native species; why should we expect more plasticity in the genetic structure of a foreign species? Gambel's Quail (*Lophortyx gambelii*), after untold centuries in southern Nevada still can exist on only about 940 square miles of the more than 14,000 square miles of Mohave Desert occurring within that state (Gullion, 1960:534). The few successful transplants of these desert quail to other areas have occurred where environmental conditions were essentially the same as in their native habitat.

Although the conifer-needle eating Blue Grouse (*Dendragapus obscurus*) is scattered sparingly throughout the higher mountain ranges in Nevada, where bristlecone and limber pine (*Pinus aristata* and *P. flexilis*) are of limited occurrence, this bird has not been able to adapt itself to a diet of either pinyon pine (*P. monophylla*) needles or Utah juniper (*Juniperus osteosperma*) foliage, and thereby occupy a vacant ecological niche covering about 15,000 square miles in that state. Nor have Sage Grouse (*Centrocercus urophasianus*) learned to subsist on the fleshy leaves of the abundant chenopods such as *Sarcobatus*, *Atriplex*, and *Grayia*, a feat which would allow them to thrive without competition on many thousands of square miles of cold-desert scrub in the Great Basin.

In northern Minnesota despite centuries of exposure to the climate of the boreal forest, the Ruffed Grouse (*Bonasa umbellus*) remains largely at the mercy of the climate, the numbers from one year to the next being largely dependent upon the vagaries of the winter weather (Gullion, 1964). These chionophiles have not adapted very well to northern Minnesota weather conditions.

Under current consideration is an additional introduction of European grouse into Lake States forests. One of these, the Capercaillie (*Tetrao urogallus*) is largely dependent upon the needles of Scots pine (*Pinus sylvestris*) through the most critical part of the winter (Seiskari, 1962:31), and this pine is of very limited distribution in North America. I don't believe we can expect this species to do as well feeding on

some other pine. Bump (1963:863) makes the ambiguous statement, "Captive capercaillie . . . accepted without difficulty white pine . . . and jack pine . . . as food." This is comparable to Nagel's 1945 food study of the Chukar Partridge in Missouri wherein he listed a number of food items utilized by chukars before they disappeared completely from the state—none of the items listed included the foods essential to this species' survival in the arid western areas where it is now established. We also know that Ruffed Grouse will readily feed on dyed, shelled corn (Gullion, 1961) but Ruffed Grouse do not thrive in the cornfields of southern Minnesota.

Another bird, the Black Grouse (*Lyrurus tetrix*), being largely dependent upon the catkins of birches (*Betula verrucosa* and *B. pubescens*) in the Old World might have better success in the extensive paper birch (*B. papyrifera*) forests of northern Minnesota (Helminen, in litt., 1964). However, it should be remembered that birch is widely regarded as a "weed tree" among foresters, and is being routinely eliminated from areas under intensive forest management in favor of the long-needle pines (which are not utilized by any wildlife species on a preferred basis).

According to Seiskari (1962) both Black Grouse and Capercaillie have very specialized habits and habitats, and by Bump's standards (1951:319) should "automatically be eliminated" from consideration for introduction.

One further point in regard to these European grouse: The object of their introduction is to provide more hunting than provided by native species, yet at their better densities on native European ranges these two species of grouse about equal the density of our native Ruffed Grouse when at *low population levels* (Seiskari, 1962:82; Jenkins, in litt., 1964; Helminen, in litt., 1964). These grouse, too, are subject to the same type and degree of population fluctuations, and would indeed be scarce at their low points (Siivonen, 1952).

In recent conversation with Arnie Belsaas, responsible for game management in one of Norway's five regions, I learned that Capercaillie are so difficult to hunt in their native haunts that special seasons are set to take advantage of a brief 2-week period of intensive arboreal feeding in the fall, and on their display grounds in the spring. Such a bird would hardly meet the needs of American grouse hunters.

When more thorough food habits and ecological studies have been made I believe biologists will find that all resident game birds living in harsh environments, whether arid or boreal are able to survive due to very specialized habits and habitats. Koskimies (1955) stresses this point in discussing the feeding habits of European herbivores, as I have done (Gullion, 1956:34–35) for the quail living on the deserts of southern Nevada. Most of the areas in North America lacking resident game birds are just such harsh, semidesert, or boreal forest habitats, having limited or specialized food resources.

In 1951 Bump said (p. 317) that introductions would be into "other coverts which never were fully occupied by native game birds . . . possessing the characteristics requisite to survival in the face of today's intensive hunting pressure," yet in at least one state virtually all of the introductions have been made into areas as fully stocked by native species or earlier established exotics, as the habitat would carry. According to Christensen (1963:15) the bulk of Nevada's releases of 2,300 Gray Francolins (*Francolinus pondicerianus*), 600 Black Francolins (*Francolinus francolinus*), and 2,000 Common Sandgrouse (*Pterocles exustus*) were made into the agricultural valleys supporting the highest densities of native Gambel's Quail in the state (Gullion, 1960). The foods taken by these introduced species placed them in direct competition with the native species, in an area where the food resource is a limiting factor. Fortunately for the native quail these exotics have apparently disappeared completely.

In spite of a costly 10-year program of foreign bird introductions into Nevada, involving several thousand birds of 12 species (including at least three species transplanted from other parts of the United States—Christensen, 1963:63), the 1957 statement (Gullion and Christensen, 1957:137) that "approximately 68,000 square miles (62 per cent) of the 110,500 square miles in the state are not occupied by any upland game bird on a permanent-resident basis" is still valid. My prediction is that it will remain so until a bird is found which can survive on the fleshy leaves of a few Chenopodiaceae such as *Atriplex*, *Grayia*, and *Sarcobatus* and the irregular seed crops of a miscellaneous group of crucifers, composites, borages, and knotweeds; or upon the needles of pinyon pine and the foliage and fruit of juniper.

Bump and Bohl (1964:3–4) list 16 game birds obtained through the Foreign Game Importation Project, plus four species obtained by various state agencies through independent sources. Of these 20 birds (some are races of the same species), only several geographical races of the Ring-necked Pheasant, the Black Francolin, and the so-called Turkish Chukar, a race of the Rock Partridge, appear to have shown much promise to date.

The form of the pheasant which has been most successful is a hybrid between a Western and Eastern Iranian Pheasant (*P. c. talischenis* × *persicus*), presently established in Virginia (Allen, 1963). Other forms of the Ring-necked Pheasant which show some promise include the Japanese Green Pheasant (*P. c. robustipes*), also established in Virginia and possibly Tennessee; the Afghan White-winged Pheasant (*P. c. bianchii*), showing some potential in Missouri and Oklahoma; the pure strain of the Eastern Iranian Pheasant in Missouri and Iowa; and the pure strain of the Western Iranian Pheasant in Virginia, Kentucky, and Tennessee.

Among the other species the Turkish race (*A. g. cypriotes*) of the Rock Partridge shows promise in California and New Mexico; and the Black Francolin shows possibility of establishment in Louisiana and maybe three other southern states.

On the other hand, the Gray Francolin which was "showing promise in . . . Nevada" in 1963 (Bump and Bohl, 1964:3) had evidently failed by 1964. Blair (1942:18) once was satisfied that the chukar would become established in Minnesota where, in spite of apparent early successes following the release of some 85,000 birds (Christensen, 1954:12), the species now persists only on a few mine dumps in the northern part of the state near Ely, where they consistently have been provided with supplemental food supplies. The failure of the widely released Japanese Migratory Quail (*Coturnix coturnix*) was particularly dramatic. This program was not connected with the federal program.

Particularly disturbing is the reestablishment of expensive game farm programs which are being justified in many states for the purpose of rearing these imported species to give them more adequate trials.

There is abundant evidence that if an exotic species is going to succeed in a new environment it will do so following the release of a relatively small number of individuals. This has been true of the establishment of Ring-necked Pheasants and Chukar Partridges, as well as European Starlings (*Sturnus vulgaris*) and the House Sparrow (*Passer domesticus*). If the release of a few dozen or 100 or 200 healthy individuals of a species fails then the release of many thousands has not proven anymore effective in assuring establishment.

After watching the conduct of the exotic bird program for nearly a decade and a half one can only conclude that the majority of the wildlife biologists who have felt it was a waste of resources have been basically correct. In some states the introductions of

exoties is being pushed when utilization of an abundant established wildlife resource is either nonexistent (as in states extending protection to Mourning Doves (*Zenaidura macroura*), Bobwhite Quail (*Colinus virginianus*), and hen pheasants—cf. Harper, 1960), or barely touching current annual production (the Chukar Partridge and grouse on many western ranges, and Ruffed Grouse in Boreal forest regions—cf. Eng, 1962). Perhaps the most unhappy aspect of the exotic program is that the search for a cornucopia of imported game birds diverts scarce resources and attention away from the research necessary for developing sound management practices leading to better handling of existing native and exotic upland game bird resources. After more than 35 years of research game biologists still do not know enough about our native Ruffed Grouse to be able to manage it successfully.

The Hamerstroms (1963:885) neatly summarize this whole matter by saying of the exotic program, "Aldo Leopold (1938) said that 'it has depleted the game funds of 48 states for half a century, and has served as a perfect alibi for postponing the practice of game management.' To this, another quarter century can now be added."

ACKNOWLEDGMENTS

For their critical review of his paper I wish to extend my sincere appreciation to Dr. William H. Marshall and to others in the wildlife management field who wish to remain anonymous.

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DEPARTMENT OF ENTOMOLOGY, FISHERIES AND WILDLIFE, UNIVERSITY OF MINNESOTA, AT THE FOREST RESEARCH CENTER, CLOQUET, MINNESOTA, 1 MARCH 1965

ORNITHOLOGICAL NEWS

IMPORTANT ANNOUNCEMENT

Treasurer C. Chandler Ross asks that all members remember to include their new Zip Code number, when notifying him of a change in address. The complete mailing of *The Wilson Bulletin* is now done by Zip Code numbers, and one must be included on each addressing stencil. Failure to include your new number will not only increase the burden of the work of the Treasurer, as he will have to write for the information, but may also delay considerably your receipt of copies of *The Bulletin.*

The Eastern Bird-banding Society announces an award of $100 to be made annually to a student, either undergraduate or graduate, who is using bird-banding techniques, or available bird-banding data as a part of his research. Applications should be received prior to 1 January. Direct all applications or inquiries to Albert Schnitzer, Chairman, Memorial Award Committee, 155 Wild Hedge Lane, Mountainside, New Jersey.

The final number of another volume of a journal such as *The Bulletin* always brings both a few sighs of relief as well as a sense of satisfaction to an editor. Not the least of the satisfactions is the ability to acknowledge publicly the assistance of those persons who have aided materially in the preparation of the volume. As usual the members of the Editorial Board, Andrew J. Berger, Tom J. Cade, William C. Dilger, William W. H. Gunn, William A. Lunk, Robert A. Norris, Kenneth C. Parkes, Raymond A. Paynter, Jr., and Olin Sewall Pettingill, Jr., have provided invaluable assistance. Don Eckelberry generously donated a painting for the color plate, and Bill Lunk, as in the past, carried out the exacting job of seeing that the painting was properly reproduced. Many other ornithologists have kindly served as reviewers of papers. This year special acknowledgment is due to Miss Mabel Stewart, of Grinnell, Iowa, for the preparation of the index to Volume 77.

It is with real pleasure that we announce the addition to the Editorial Board of Dr. Robert W. Nero, of the University of Saskatchewan, Regina Campus.

The name of Ralph J. Zaenglein was inadvertently omitted from the list of registrants at the 1965 Annual Meeting. Mr. Zaenglein's name brings the total registered attendance to 213 and adds one more state, Tennessee, to the 28 previously listed.

Notice has been received that among the cases to be considered for possible uses of plenary powers by the International Commission of Zoological Nomenclature is the validation of the generic name *Cacatua* Vieillot, 1817. Z.N. (S) 1647. Persons interested in commenting on this case should communicate with the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7 before 13 February 1966.

Dr. N. R. Whitney, Chairman of the Local Committee for the Sylvan Lake meeting informs us that he has on hand a quantity of the decals used in making the souvenir plates for the Annual Banquet. Interested persons may obtain these decals free of charge, or may purchase a plate made with them for $1.25 by writing Dr. Whitney at 633 South Berry Pines Road, Rapid City, South Dakota.

LETTER TO THE EDITOR

Sexual Dimorphism in Relation to Foraging Behavior in the Hairy Woodpecker

Readers of L. Kilham's paper (1965. *Wilson Bull.*, 77:134–145) on sexual differences in foraging of the Hairy Woodpecker (*Dendrocopos villosus*) in New Hampshire may be interested in learning something of the morphological correlates of the observed behavioral differences. As Donald R. Giller and I have shown (1963. *Amer. Mus. Nat. Hist. Bull.*, 124:261–266), bill length in species of woodpeckers is almost invariably more dimorphic sexually than are other linear dimensions of body parts such as wing or tarsus, and the degree of sexual dimorphism varies markedly among genera, species, and races. Interpreting this variation in adaptive terms, we predicted that sexual differences in bill size in woodpeckers would prove to be related to differential niche utilization by the sexes, but at the time we had no field data supporting or refuting this contention. I have since been able to demonstrate a relation between degree of sexual difference in foraging behavior and degree of sexual dimorphism in bill size and proportions in species of *Centurus* (Selander, *Condor*, in press), and Kilham's work also provides strong support for the hypothesis. Additional data suggesting significant sexual differences in feeding habits of the Hairy Woodpecker, Downy Woodpecker (*Dendrocopos pubescens*), and Northern Three-toed Woodpecker (*Picoides tridactylus*) are found in the work of Massey and Wygant (1954. *U. S. Dept. Agric. Circular* No. 944) on the control of the Engelmann spruce beetle (*Dendroctonus engelmanni*) in Colorado.

From data presented by Ridgway (1914. *U. S. Natl. Mus. Bull.* 50, Part 6:201–228), I have calculated average percentage differences in three linear dimensions for 18 subspecies of the Hairy Woodpecker: bill length (exposed culmen), 11.0%; wing length, 2.1%; and tarsus length, 3.8%. In bill length, the Hairy Woodpecker is unusually dimorphic for a continental species but is exceeded by certain insular types of other genera. Average degrees of sexual dimorphism in bill length in other North American species of *Dendrocopos* are: *D. pubescens*, 4.2%; *D. nuttalli*, 7.2%; *D. scalaris*, 11.0%; *D. stricklandi*, 9.2%; *D. arizonae*, 11.6%; *D. albolarvatus*, 8.9%; and *D. borealis*, 5.1%.

From an ecological standpoint, an estimate of the degree of non-overlap in bill size of the sexes is more significant than percentage dimorphism based on mean measurements. Using measurements of specimens in the Museum of Vertebrate Zoology, I have calculated coefficients of sexual difference (see Mayr et al., 1953. Methods and principles of systematic zoology. McGraw-Hill, N.Y.) in bill length (full culmen from base) for the subspecies studied by Kilham (*D. v. villosus* from the northeastern United States), which shows a 10.2% difference in bill length, and for the slightly more dimorphic subspecies *D. v. leucothorectis* (12.2% for a sample from California and Nevada). The coefficients indicate 92% joint non-overlap between the sexes in bill length in *D. v. villosus* (C.D. = 1.45) and 95% joint non-overlap for *D. v. leucothorectis* (C.D. = 1.60).

Because of its wide distribution, the Hairy Woodpecker provides exceptionally good material for studies of geographic variation in differential foraging in the sexes in relation to regional variation in quality and quantity of food and in intensity of competitive interactions with other woodpeckers and species of similar adaptive type. However, as noted by Kilham (op. cit.:144), such studies must allow for effects of seasonal and secular changes in populations of both predator and prey species as well as in those of competitors. But with these and other variables controlled, analysis of the ecological basis and evolution of sexual dimorphism in size and differential niche utilization would be possible.—Robert K. Selander, *Department of Zoology, University of Texas, Austin, Texas, 1 July 1965.*

ORNITHOLOGICAL LITERATURE

THE LIVES OF DESERT ANIMALS IN JOSHUA TREE NATIONAL MONUMENT. By Alden H. Miller and Robert C. Stebbins. University of California Press, Berkeley and Los Angeles, 1964: 7¼ × 10⅝ in., 452 pp., 7 col. pls. and 141 figs. (including maps, diagrams, drawings, and photos.). $10.00.

The Joshua Tree National Monument is an extensive area administered by the National Park Service, situated in the desert of southern California just southeast of the high coastal San Bernardino Mountains. Its elevations range from slightly below 2,000 feet to about 5,500 feet, encompassing three major vegetative belts—creosote bush, yucca (including the Joshua tree), and pinyon.

"The Lives of Desert Animals in Joshua Tree National Monument" treats the birds, mammals, amphibians, and reptiles found in the Monument. There are accounts for each species, preceded by a discussion of problems of desert life, a survey of the environments of Joshua Tree Monument, the plan and scope of field study, and a faunal analysis.

The field studies were accomplished mostly during eight principal trips to the Monument from 1945 to 1960 by workers of the Museum of Vertebrate Zoology at the University of California. Observations of others not connected with the University were also used in preparing the species accounts. Areas formerly within the Monument were also covered, especially Little Morongo Canyon and Twentynine Palms. In a publication of this scope, one could wish that the supportive field work was more comprehensive. There were no trips during the winter, and only one during the summer season proper. The trips lasted from 5 to 25 days, averaging 12 days.

The vertebrate fauna of Joshua Tree Monument was found to be predominantly one of desert affinities, and to include in greatest proportion those species that occur in the Mohave Desert to the north, although the influence of the Colorado Desert to the south is also quite marked. The higher parts of the Monument permit the eastward extension and isolation of species and races characteristic of the coastal districts of southern California.

The species accounts contain a great deal of interesting information, and reflect the attention paid to note-taking in the field. Particular emphasis is placed on breeding and molting phenology, geographic variation, and the effects of desert conditions upon animals. The authors sometimes indulge in speculations that point the way to possible profitable future investigations.

A claim is made that migrant birds crossing western deserts are overcome at times from water and high temperature problems, with "resultant high mortality." This claim is supported by the poor condition of 4 out of 17 Traill's Flycatchers, 4 out of 13 Orange-crowned Warblers, 3 out of 11 Nashville Warblers, 2 out of 8 Black-throated Gray Warblers, and 5 out of 12 Wilson's Warblers that were collected. These birds were taken in late August and early September, when temperatures are often at or near maximums for the year. From 25 to 40 per cent of such migrants, opine the authors, would not live to complete the desert crossing. This is a phenomenon of much interest, and leads to speculation over the wisdom of Nature in permitting these birds to follow such hazardous trails. I have observed birds in the even warmer desert of the lower Colorado Valley and southwestern Arizona for many years, but never realized that such mortality was present. Certainly one very rarely finds a dead or dying bird. I would feel more satisfied with the authors' findings if they were supported by a larger sample of birds examined from several localities for several seasons.

A few items worthy of note: Mourning Dove going without drinking water for 4 or 5 days in an emergency (p. 12); Horned Larks "colonizing" in favorable years, "finding these places through vagrancy" (p. 15); mixed coveys of Gambel's and Mountain Quail (p. 62); nesting of Cassin's Kingbird at Twentynine Palms (p. 114); lack of Common Ravens (only five records; p. 141); adult Plain Titmice and Common Bushtits far outnumbering young in the fall, while the reverse is true in Bewick's Wrens! (pp. 149, 156, 161); and ignorance of two Mountain Sheep lambs in the caption under photograph (p. 348).

The many photographs and black and white drawings add greatly to the interest and value of the book. The drawings, as well as six color plates, are by Gene M. Christman. He is not a top-register artist, but his portrayals are interesting and accurate. He often shows his subjects behavioristically—a jack rabbit resting in the shade of a desert tree, a Loggerhead Shrike in a prey-glide, Cliff Swallows obtaining nest-mud, etc.—Gale Monson.

The Integration of Agonistic Behavior in Steller's Jay Cyanocitta stelleri (Gmelin). By Jerram L. Brown. University of California Publications in Zoology, Volume 60, Number 4, University of California Press, Berkeley and Los Angeles, 1964: 106 pages, 2 pls., 13 figs. $2.00.

This is Jerram L. Brown's second and longer paper on the behavior of Steller's Jay. (For his first paper, see *Condor*, 65:460–484, 1963.) All data on which this work is based were apparently obtained by him during 730 hours spent observing wild jays in a public park adjacent to Berkeley, California, from March 1957 through April 1960.

The paper begins with a statement of two goals: (1) to provide information that will support or modify existing theories on agonistic behavior and (2) to be exploratory in the sense of attempting to identify and describe the agonistic behavior patterns of Steller's Jay. Only the second goal seems to have been achieved, although the coverage of behavior patterns is probably not exhaustive. While this paper could be used to support some existing theories on agonistic behavior, Brown attempts to modify existing theories, relating his findings to certain alternative propositions of his own, none of which appears to be supported by his data. Thus any attempt to support or modify existing theories concerning agonistic behavior based on evidence in this paper should be considered very tentative since, as Brown notes in the last sections of the paper, the agonistic behavior of Steller's Jay is impressively variable and cannot be reduced to a few stereotyped behaviors. The principal contribution of this paper is its basic information about agonistic displays in Steller's Jay.

The introduction includes a discussion of some theoretical constructs used in establishing Brown's terminology and point of view concerning agonistic behavior. Very likely many animal behaviorists will not entirely agree with Brown's use or interpretations of some terms and concepts as used in this study, since these terms and concepts already have evoked controversy among psychologists and ethologists. For example, Brown includes the term "motivation" in his "integration of behavior," defining the latter term as "the process which coordinates effector actions into behavior patterns." To me, it would seem at least reasonable to reverse the situation, including "integration of behavior" under "motivation." Also, Brown broadly defines "neurobehavioral mechanisms" as "the activity of a population of neurons common to a group of functionally related behavior patterns," but at various points in the text this term seems to be interchangeable with "motivation," although the definitions are not the same.

The main portion of the text is composed of descriptions of eight body or feather postures and of 15 vocalizations used in agonistic situations. Each description is immediately followed by a discussion of the relationship of the particular behavior to that of the other agonistic patterns. However, this organization—description of behavior followed by a discussion of its relationships—can be confusing to the reader since Brown frequently discusses one agonistic behavior in relation to another not yet described. This situation could have been remedied had Brown devoted an early section of the paper solely to the identification and description of the various behaviors, later discussing the interrelationships among these behaviors. Also confusing is his discussion of some agonistic behaviors in relation to non-agonistic behaviors which lack either adequate description or reference to other works. This creates the possibility of misinterpreting the nature of the behaviors and their interrelationships, unless the reader is already familiar with the behavioral repertoire of Steller's Jay or closely related species.

In his attempt to provide a complete repertoire of agonistic behavior in Steller's Jay, Brown includes several questionable cases. Of the eight body or feather postures mentioned, he includes two that, he implies, have no recognizable agonistic function. Similarly, six of the 15 described vocalizations are probably not agonistic (and four of these six were heard only once). He mentions four additional vocalizations as being heard in populations other than the one under study and considers them to be variations of the observed agonistic vocalizations, but he gives little evidence to support this conjecture. Both the difficulties in relating agonistic to non-agonistic behaviors and the inclusion of questionable agonistic behaviors could have been circumvented had this paper been preceded by an introductory ethogram on the Steller's Jay. The reader would then know with certainty which behaviors were agonistic or non-agonistic displays and could more readily interpret their relationships. Such a preliminary ethogram is particularly desirable in the case of an animal which is as variable in its behavioral repertoire as Brown reports for this jay.

Most of the quantitative data are presented both in tabular and verbal form, showing relationships between the various displays and vocalizations. The tables present the raw numerical data, giving the frequency of one observed display in relation to another, while the histograms usually present this frequency distribution in percentage form. In discussing this material, Brown makes frequent reference to significant differences between related displays or to correlations between behaviors, but he gives no reference to the statistic used to determine significance or correlation in most cases and no reference to a statistical source. He often used the mode to show relationships between displays, but this use seems inappropriate in many cases where the sample size was small. In general the discussion seems to be based on the tables, but at least one of the tables (Table 7) I could not decipher. Probably some information was omitted from the table since the discussion did not relate directly to material in this or in any other table. While behavioral studies such as this one benefit greatly from statistical analysis, greater care should be taken in such an analysis than is shown here. More discriminating use of statistical methods would have clarified the discussion, reduced its bulk, and also permitted the spot-lighting of the more important relationships beween the various agonistic displays discovered.—A. R. Weisbrod

Vibra el Llano. By Paul Schwartz. Naturaleza Venezolana 2 and 3. Instituto Neotropical, Apartado 4640 Chacao, Caracas, Venezuela. Two 33⅓ rpm. records. Narration

in English. (Spanish version also available.) On sale in United States at Cornell Laboratory of Ornithology, Ithaca, New York. Each record $7.75.

These are truly beautiful recordings of Venezuelan birds found in the Orinocan plains called El Llano—vast area of grassland, interrupted by lagoons, patches of woodland, and gallery forest. The first disk of two sides (marked "2" because Schwartz had earlier published another Venezuelan bird record) emphasizes chiefly the seasonal and habitat differences in the birds to be heard. This record contains brief comments naming each species, as it appears, and occasionally telling us something about it. The second disk (marked "3") is totally free of commentary, and lets the animal voices—chiefly birds, but also including howler monkeys, frogs, and insects—paint eight environmental sound pictures at varying times of day. Over 90 species of birds and a half dozen mammals are recorded.

To those who have listened to birds in the lowlands of Middle or South America these records will be evocative of the warm pungent fragrance of tropical days. Some of the species occur from Mexico to Argentina and hearing them rouses nostalgic memories. Many vocalizations are provided that, so far as I can recall, have not appeared in any published record. A good proportion of the species are not technically songbirds but that does not make their voices any the less interesting. We hear such species as the Hoatzin, the Sunbittern, and the Horned Screamer and several kinds of ibises, herons, owls, and hawks, including some of the tropical falcon allies. And of course there are the ubiquitous tyrannids, woodcreepers and their relatives—not to mention the tropical wrens of various kinds.

An informative leaflet, in both Spanish and English, gives a description of the habitats (with four helpful photographs on the jacket to sharpen the picture). The Spanish, English, and scientific names of each species are stated in order of appearance, on each disk, side, and band. The Spanish names are drawn from the Venezuelan Check-list of Phelps and Phelps, while the English names agree essentially with those of deSchauensee's recent "Birds of Colombia," thus enabling the auditor to determine (without going to a museum) what the bird he is hearing looks like. Apart from the interest in hearing the voices of unfamiliar birds, I was curious to learn to what extent the notes of the Venezuelan population might differ from my recollection of the same species as heard in Panama or elsewhere. In some cases there was no difference obvious to my ear; in others I would certainly not have recognized the voice of the Venezuelan form. Records such as these cannot supply enough data for comparative studies, but they serve to suggest lines of inquiry that may be pursued through the facilities of the Cornell Laboratory of Ornithology, where Schwartz and other workers file copies of their tapes.

I must confess to some perplexity in regard to the second record, which avoids the interruptions of human commentary. While most of the species heard are those already identified on the first disk, there are 26 new ones introduced. To be sure, the program notes clearly indicate what these are and show their position on the side and band in relation to other species heard. Nevertheless, in a few cases when several new and unfamiliar species followed each other, I felt uncertain whether I was hearing two different vocalizations of one species or those of two species. If the second record is designed solely for atmospheric or musical effect, this criticism has no validity; but if intended also for some ornithological function, its usefulness is affected to the degree that identification is rendered difficult or uncertain. There is no doubt that poetically this record gains by letting the birds speak for themselves, but in this instance, as an ornithologist, I begrudge the sacrifice of the practical to the aesthetic.—E. Eisenmann.

PENNSYLVANIA BIRDS: AN ANNOTATED LIST. By Earl L. Poole. Livingston Publishing Company, Narberth, Pennsylvania [1965]: 6 × 9¼ in., x + 94 pp., 34 maps (2 on the endpapers) and many drawings by the author. $4.00.

This little book is essentially a résumé of the past and present status of the birds of Pennsylvania and, we are told, an abridged version of a definitive work in preparation by the same author. Introductory material includes a brief history of local ornithological work from its beginning and a description of the state's physiography and faunal zones (= "life zones" of J. A. Allen and C. H. Merriam). The book's raison d'être, the annotated list, "treats 361 species for which records have been authenticated and 47 additional species whose status is hypothetical or questionable" (quoted from the flyleaf of the jacket). Concluding the book are 32 maps showing the "known and suspected breeding localities for certain species of limited or interrupted distribution in Pennsylvania"; a bibliography including "only the more extensive local, county, and regional lists that are cited most frequently in the text"; and an index to species. Scattered through the text are the author's skillful drawings, many of them used in other books. The front endpapers show a map of the life zones in Pennsylvania and the back endpapers the physiographic divisions of the state.

I have only the highest praise for the format, typography, and page-by-page layout of the book and for the care and precision with which Dr. Poole has prepared his text. Regrettably, in following the nomenclature of "The A.O.U. Check-List" (fifth edition, 1957), he has repeated certain errors that have since been corrected (see *Auk*, 79: 493–494, 1962). Thus Red-winged Blackbird is still "Redwinged Blackbird," *Bombycilla garrulus* still "*Bombycilla garrula*," etc. But this is a small matter.

The one serious fault I find is Dr. Poole's attempt to use life zones as one of the means of accounting for the distribution of birds. Ecologists have demonstrated convincingly that life zones, except in the more northerly latitudes and in high-mountain regions, defy satisfactory mapping and do not embrace the breeding ranges of any one bird species. This is certainly the case with the life zones in Pennsylvania, particularly the so-called Alleghanian and Carolinian. Glancing at the map of life zones in Dr. Poole's book, one would suppose that they are sharply demarked, but one has only to read the text to realize how hopelessly vague they are. Furthermore, one soon discovers how useless they are when he notes that only about 15 out of the 361 species in the annotated list are assigned to zones—usually two zones rather than one.

A more meaningful way of presenting distribution in a state such as Pennsylvania is to describe the principal physiographic regions (as Dr. Poole has done briefly), then note their climatic and vegetational characteristics and name the bird species that typify them. This method was admirably demonstrated by Robert A. Norris in writing an introductory section, "Physiographic & Biogeographic Regions of Georgia," in "Georgia Birds" (by Thomas D. Burleigh, University of Oklahoma Press, 1958), and I commend it to Dr. Poole as a model for his forthcoming definitive work and for other local and regional treatises on birds.—OLIN SEWALL PETTINGILL, JR.

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By Mildred Stewart

This index includes, in addition to names of genera, species, and authors, references to the following topics: anatomy, behavior, distribution, food habits, measurements, migration, molts and plumages, nesting, parasitism, physiology, populations, predation, taxonomy, voice, and weights. Also included are references of biological significance to reptiles and mammals. Names of new forms described in this volume are printed in **boldface** type.

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This issue of *The Wilson Bulletin* was published on 27 December 1965

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Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the AOU Check-list (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subsequently identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited; otherwise, follow the "Style Manual for Biological Journals" (1960. AIBS). Photographs for illustrations should be sharp, have good contrast, and be on gloss paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A Word to Members

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the printer of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated in the mailing list and there is a printer's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

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If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, C. Chandler Ross, Academy of Natural Sciences, 19th and Parkway, Philadephia 3, Pennsylvania. He will notify the printer.

PLAN TO ATTEND THE 1966 ANNUAL MEETING

The 1966 meeting of the Wilson Ornithological Society will be held from Thursday to Sunday, 29 April through 1 May at the Pennsylvania State University, University Park, Pennsylvania (on maps, adjacent to the town of State College). Sponsoring organizations are the College of Science and Continuing Education of the University, and the Carnegie Museum, Pittsburgh. The chairman of the local committee for arrangements is Professor Merrill Wood, 312 Life Sciences Building, The Pennsylvania State University, University Park, Pennsylvania 16802.

The meeting will open Thursday evening with a coffee hour in the new Conference Center. The paper sessions will be held on Friday and Saturday with early morning trips to local areas. Sunday field trips will be to the Bird Population Netting Project, Centre County Barrens for warblers, Black Moshannon Lake for migrating waterfowl, and the Powdermill Nature Reserve, where the Carnegie Museum operates a bird-banding station.

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